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Journal of Geographical Research

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Dr. Jose Navarro Pedreño

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ARTICLE

Laboratory Life: Twenty Years of Experimental Research with Locals and New Comers in Remote Rural Areas

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ABSTRACT

Through the Latour concept of philosophy of science of laboratory life, the life course of a (geo) ethnographer researcher is analyzed, in order to establish the emotional or more personal dimensions that do not usually appear in research papers, but that have notable relevance in qualitative research. The text is structured in three large parts: A conceptual vision of the new experimental geography; the experimental geo-ethnography in old social, new social and place scenarios; and finally, the most personal and emotional dimension of the research. The first part establishes the geo-ethnographic experimental context and the assumptions in fieldwork, in addition to the geo-ethnographic reconciliation process. In the second part, the main qualitative research problems related to mobility, resistance and dynamics in place are established. Finally, in the third part the research perceptions, the personal experiences, and the emotional dimension of the research in remote rural areas are established. The laboratory life of a researcher, allows one to establish scalar conclusions and rigor in qualitative research.

Keywords: Laboratory life; Qualitative research; Rural areas; Social change; Experimental research

1. Introduction

From the Latour concept of laboratory life ^[1], the dimensions of the life course of a qualitative geographer are revised in this contribution. The debate on the rigor of qualitative methodology has a certain

tradition in human geography ^[2-4], based on the lack of transparency of qualitative research about the research process in aspects such as the absence of verification by other research, the variable and scattered nature of the qualitative data, the subjectivity in the selection of informants in fieldwork ^[5]. As Baxter

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and Eyles ^[6] suggest, there is a permanent tension between the creativity of the qualitative research process and the evaluation or verification. Context, contingency and the specific positions in/of subjects are central to qualitative inquiry and should not be considered to establish scientific rigor ^[6]. Consequently, rigor in qualitative methodology should not be interpreted in the same way as in quantitative approaches. One possibility to increase “rigour” is through sharing and “reusing each other data” ^[5]. In this way, we can extract great value with the sum of original qualitative data, in a long-term research strategy that allows meta-synthesis to be generated ^[5]. As suggested by Wimark, Lewis, Caretta ^[7], “the life events and transitions that intersect with fieldwork have been largely absent from these discussions”.

In this paper it was argued that the life course of a researcher and a study subject is a way to increase the scalar dimension of qualitative visions of the research. As suggested by Latour: The idea of an ethnographic study of scientific practice has given rise to a body of work which comes to be called “laboratory studies” ^[1]. Laboratory life is a life dedicated to the qualitative research of a subject expressed in a geographical manner: “The life courses of researchers and participants are therefore not only linked temporarily or professionally in specific field sites” ^[8].

In the context of the last research tendencies in human and rural geography associated with the encounters and assemblages of heterogeneous, fluid and hybrid socio-spatial realities suggested by Massey, Murdoch, Leitner or Willet ^[9-12] between other academics, the main parts of this paper are: (1) Experimental life course in depopulated areas, some theoretical considerations in the context of human and rural post-modern geographies. (2) Social change in depopulated areas: Old social, new social and place dimensions. (3) Researcher and life experienced in depopulated areas: Perceptions, daily and events experiences, life and emotions. It’s a summary of my research life in marginal areas between the years 2000 to 2020, close recently.

2. Experimental (geo) ethnography

The academic context of experimental geo-ethnography is based on three dimensions: (1) post-modern experimental geography: Deconstructing the binary relation research-researcher and creating new binary synthesis ^[13]. Our binary worlds are in constant flux where the fieldwork context and experiences and life course have a reciprocal influence. (2) Experiment with others and imaginative geographies: “One part of the most significant contributions of postmodernism is supposed to be its attention to ‘multiple voices’, to the dangers and universalising a particular point of view, but in many cases ...” ^[14]. This trend suggests a particular point of view of the research in the selection of participants. (3) Imaginative and reflexive geographies: “By reflexivity we mean to refer to the realization that observers of scientific activity are engaged in methods which are essentially similar to those of the practitioners which they study” ^[1].

The assumptions in fieldwork, are mainly: (1) Multiple popular voices in the qualitative research; (2) (management of) other discourses in the margins of the community; (3) progressive (domestication of) differences between people in the development of qualitative fieldwork ^[14], in a close rural community.

2.1 Experimental life course

The Initial assumptions of the experimental life course are mainly: (A) “Insider of complete member research” ^[15] as the sum of: (1) personal narrative experience; (2) narrative as encounter/dialogue; (3) below as political/subaltern ^[15] in marginal and small-scale situations. (B) “Extensive research cannot establish causation, only intensive research—focusing on individual cases—using qualitative methods” ^[13]. (C) Human geographic fieldwork is essentially a dynamic confluence of three life courses: Researcher, participant and place ^[8].

The life course is a theoretical orientation dedicated to the study of the lives of people based on the micro experience of individuals in a specific socio-geographical context commonly used in so-

cial studies ^[16-20] and in human and social geography in the last twenty years in fields of study such as race, culture, migration, reproduction and locational choice ^[7]. On the contrary, an experimental researcher's life course is the account of an extended period of time dedicated to the qualitative analysis of the same subject/object of study by a researcher with few references in the literature ^[21] or non-existent in long periods of time. This account includes responses and emotional changes of the researcher in the continuous process of fieldwork, in this sense personal knowledge or personal oral history is used as research material. The experimental life course of a researcher is not an auto-ethnography or an autobiography ^[22,15], since it aims to situate the researcher's experience in successive research scenarios throughout professional life. Personal experiences in a place situated in larger processes of research are a scalar factor for increasing the results and the power of scientific conclusions of qualitative methodology. As Wimark, Lewis and Caretta ^[7] suggest: "The life course framework asserts that social and professional lives are affected by geographically situated and temporality contingent norms and institutions".

The experimental life of a researcher, suggest two main considerations: (1) Experimental situates the (lives of) researcher in (successive) research setting or places. "Experimental gained which immerses in the day-to-day activities of working scientists" ^[1]. (2) Experimental form of representation, "not conventional" is usually associated with (auto) ethnographical approach in the context of one research. One life is the sum of multiple experimental (successive

experiences) forms of representation in a specific research subject. Research lives with multiple roles and emotions (**Figures 1 and 2**).

The process of reconciliation (of research and researcher) suggests two main sides: emotions and qualitative research and emotions and personal-professional life. (1) Emotions and research: Mainly based on the co-evolution of the researcher's life course and the fieldwork. There are few studies on the influence of life events in the fieldwork ^[7], or how fieldwork can impact life course ^[23]. In the extensive "in time" process of qualitative fieldwork the researcher can/must reconcile their professional interests and their personal aspirations.

(2) Emotions and life: Variable emotional exchanges associated with each fieldwork ^[8], in a permanent and cumulative process. Emotions influence the approach of fieldwork over an extensive time. Changes in the sense and intensity of emotions with life course is a relevant consideration in the extensive fieldwork: "The field is not only a geographical location but rather a set of relationships nurtured, contested and developed during the course of long fieldwork phases" ^[24].

The life course has two major interpretations: (1) Approach (continuity) or (2) derive or secondary method (segmented/sum) (**Figures 1 and 2**), with successive turning points in the life course and research life. Each new fieldwork research field and personal life defines a new encounter that opens through turning points, which can have a scalar dimension in an extensive life course.

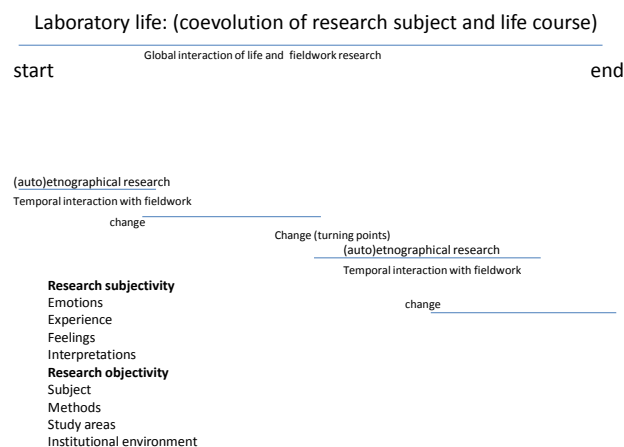


Figure 1. Modalities of life course research.

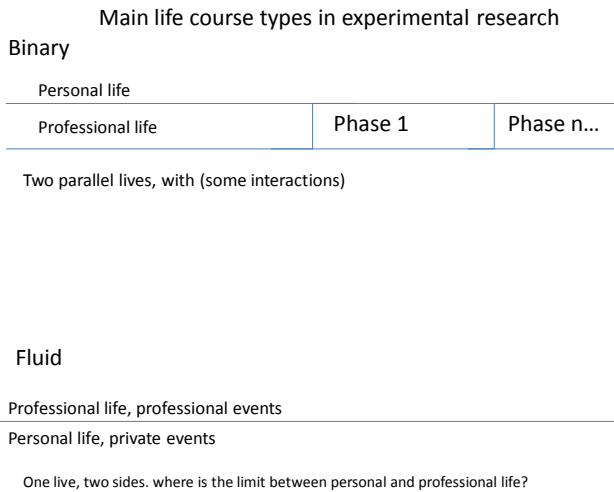


Figure 2. Main life course types in experimental research.

2.2 Experimental research in marginal and depopulated areas

The experimental research suggests two complementary perspectives or encounters: (1) From depopulated area: (a) Multiple (but few) particular voices (in the making) of research. (b) (Key) Moral situations in the field: The relevance of selection of events or places and social micro processes. The field is open to offers for possible ways of research fieldwork, but the decision of the final route is on the side of the researcher... (2) From research/cher: Experiment with my own perspective (between few others), or in others words: Few others in depopulated and marginal areas and the other researcher between others in a close experimental relationship.

This perspective suggests a route from the coproduction of research to the coproduction of research: The gradual adaptation of the researcher point of view to participants. This research context acquires remarkable relevance to the positionality of researchers that has diverse perspectives in human geography in the last twenty years: ethical, cultural, gender, and place studies ^[16-19]. In the experimental life course there are successive changes in the positionality of a researcher's in the depopulated area with two sides: (1) Auto positionality (self-narrative). Emotions alter the positionality of the researcher in the course of research or successive research. (2) Context position-

ality (social context of a place in a micro historical time). Situating the biography of a researcher in a research setting or in a successive research setting is possibly a natural and precise subjective interaction ^[15]. The inevitable of emotions ^[16] and daily experiences of researcher in the context of a precise and objective subjectivity of qualitative researcher is a key factor in the rigor of qualitative methods. The researcher is a temporal another in the close and traditional rural community. In place positionality depends on the perception of the researcher ^[20,19], but also on his successive personal circumstances ^[21]. There are emotional and positional changes that are described over a long period of time. Consequently, the researcher's interpretations depend in a certain way on their positionality in the life course ^[22,23]; they are like their intentionality lenses.

The relationship between professional life course and personal life can have two notable interactions (**Figure 2**): (1) A binary vision in the form of parallel lives with certain, but limited, interactions and (2) a hybrid vision where personal life is confused and the professional. The hybrid and the fluid are not only spatial concepts of research ^[24], they also affect the researcher. The fluid relationship between the qualitative researcher and research is a close relationship ^[25]: "Research subjects can also affect a researcher's trajectories in the research process" ^[21]. Personal changes affect, to a greater or lesser extent, the research trajectory ^[26], sometimes they can lead to abandoning qualitative research or, on the contrary, embracing (geo) ethnographic methods.

A singular combination of small voices in small territories or spaces: Local causes and things/being "out there" ^[27,28], and the recent new centrality of the other places. This is my center in Hooks expressions—the remote places are my center of research ^[29].

2.3 Main (successive) phases in a biographical perspective

The personal stories of a researcher affect the study subject, but also the research subjects affect a researcher's trajectory in the research process ^[21,26]. From a biographical perspective and cumulative

experience of research, from the initial archival research to experimental ethnographic research we introduce the personal life course.

When between 1985 and 1986 I participated in the reconstruction and recovery of two abandoned towns in the heart of the Pyrenees or in the north of Cáceres due to the construction of a reservoir, I began my interest in the subject of depopulation and abandoned towns that have accompanied me until 2022. When I started on this subject I was a geography student and to obtain my Bachelor's thesis (BSc) in 1987 I was oriented toward the policy of colonization and the creation of new towns, in the Ph.D. thesis I extended the historical period from the mid-nineteenth century until the transition to democracy in Spain and the spatial dimension to the entire national territory. When I get a stable research position, I start a research program on depopulated and marginal areas that has lasted 20 years.

The evolution of the research has four essential phases, are cumulative, but which are also points of change in the methodological orientation, parallel to personal changes in my biography:

1) "Fieldwork" in local archives (documents and facts): Local sources, written texts, historical perspective, power perspective, close environments, and the descriptive introduction in research "scene" ^[19]. The local archives and the archives of the Department of Agriculture were the main sources of my early investigations of colonization policy. They are fragmentary archives, in many cases with conservation problems, where it was necessary to review a lot of documentation to find the data that was needed for the investigation, usually in inappropriate places with cold or heat. The information obtained is about the history of the political space of the municipality and about the historical policy of colonization. An adequate politics of archives was necessary ^[30,31], due to the difficulties of consulting the archives and documentation. The accessibility, the conservation, the ideology of the texts written at that time suggest a politics of archival research that connects the local power of the municipal archives and the state power of the departmental archives. In this stage I test the

historical demography with local archival data, to analyze in detail the evolution of small population entities created during the Franco regime. With the latest research on lost trails, I go back to consult this type of local archives mainly to indirectly date the rural routes ^[32], which are often phantoms in reality and in the archives themselves. It is necessary to selectively consult local archives to extract sufficient contextual data on ghosts from the past in the territory.

2) Numbers (data and statistics) and key discourses. The distance between the official data and the reality in depopulated areas, suggests no more numbers in my research. When I start my research I personally conclude that micro research is not possible to use statistical sources. In many towns I read in the statistics 'n' inhabitants and when I went in winter nobody or practically nobody lived there. It happened to me many times. This experience led me towards a strictly qualitative methodology. In this biographical phase I also investigate new politics in rural areas associated with the geographical debate of rural change and restructuring ^[33], especially through the key works in collaboration with Professor Hoggart on rural restructuring ^[34]. The relevant role of stake holders in innovative rural-agrarian politics—agri-environmental policies and early retirement of farmers—is another area of study ^[35,36], in a period of notable academic contributions in this research area ^[37]. These investigations are based on the analysis of the written and oral discourses of stakeholders at different scales and on policy analysis. With these investigations I personally reflect on where Geography is, given that it is necessary to stick to the rural analysis of public policies, as an established research scenario.

The weakness of statistics in micro analysis—the statistical data does not offer a great picture of the reality—and a personal evolution towards the construction of problems and research to modestly add something to rural geographic theory move me towards the qualitative analysis of new social groups and old social groups, in a work and study strategy that will last for 20 years.

3) Discourses, key interviews, singular voices,

check popular data in the field and check qualitative informations with other sources. The beginning of this phase is influenced by the notable socio-cultural turn of rural geography and the new study strategies that emerge in this period. In particular, mention the works of Cloke et al. on writing the rural or the other rurals, the generalization of the use of Deleuze's work and Valentine's contributions on encounter and difference^[38-41].

This research phase suggests a variety of key close encounters, based on the relevance of the selection of particular positionality^[30]: "Qualitative interviewing is not a laboratory experiment; it demands adaptation, flexibility and accommodation"^[30]. In this biographical/professional stage, it was a question of selecting in the field a few representative cases of types of people that would allow the establishment of causal relationships on geographical processes^[42,43]. Each person was interpreted as an analytical key. For many years, the study of new comers^[44-46] in depopulated areas and the resistance processes of farmers in remote rural areas tried to select the right people who represented key types to establish causal relationships in the processes of geographic change and restructuring^[47-52]. The geographical distance between selected cases suggests the politics of geographical dispersion in fieldwork. In this sense, one difficulty was the development of interview programs in extensive geographic areas. In short, the fieldwork was about contacting, identifying key discourses of new comers in depopulated areas. The research is finally focused on new comers' that were also new social groups of urban origin and define new social groups in rural areas, with a biographical vision of the urban-rural movement. Subsequently, I was concerned about the resistance processes of the local populations with two aspects: Resistance in a socio-geographical context of sparse population and resistance to the arrival of new settlers.

4) Discourses and experimental, extended stay in the field, (auto) ethnographical perspective, and need to understand the depopulation in my own experience. This phase is driven by the roots: "Autoethnographic self-narratives may take a variety of forms and

emerge from a range of speaking positions"^[15,53-58]. In this last phase, it was necessary to understand the transformation dynamics in geographical places that were representative^[59-61]. The site selection process was very relevant, as they had to be representative of certain types of remote and unpopulated areas. Subsequently, in each place, the social dynamics were analyzed, especially the encounters between old and new populations, a concern that was raised personally in the previous phase. The permanence in the area was notable in order to experience in our own daily life the dynamics of uninhabited areas. In short, in this last phase places and people are analyzed. The relevance of the place in the generation of new social subgroups and in the establishment of key discourses is another purpose of research. In this context is remarkable the skepticism of farmers is placed in the process of research^[62-66].

The opening of a new phase does not eliminate the orientation of the previous ones, it is a cumulative and pyramidal process in the life of a (geo) ethnographer researcher^[30], simply each phase has another main orientation, which coincides with changes in private life.

3. Experimental research and social change in depopulated areas

With extremely few populations... it is possible to ask what (social) innovation is. Or what is social change? With few people, more individual identities than groups identities or strategies in a close community. The processes of social transformation are processes of individual change in closed communities^[67-69]. Multiple processes of permanent becoming in place (with negative transformation in time) are a key factor of research.

The hybrid perspective of the researcher in the construction of the research problem suggests two sides: (1) The hybrid perspective of other people in the area: New others and old others. (2) Hybrid relations between the researcher and depopulated marginal areas (spaces and people).

In this research context, three successive research strategies in my biographical or laboratory life per-

spective: (1) New social groups (mobility), (2) old social groups (permanence and resistance), (3) place research: Social heterogeneity in place (mobility and permanence), and the recent re-re-change of new populations by new populations.

3.1 Experimental research and new social groups: Mobility

This period of research is inspired by the contributions on the middle classes of Professors Cloke, Phillips and Thrift in relation to “the new middle class and the social construction of rural living”^[44] and especially the contributions of Professor Hoggart about “the middle classes in rural England 1971-1991” and “the diluted working classes of rural England and Wales”^[45,46]. The qualitative value of the newcomers for other people suggests some particular visions or approaches: (A) The contribution of the new service class to the process of rural restructuring is limited in statistical terms, especially in remote areas^[47,48]. (B) The migration of professionals is usually selective. People (newcomers) have a qualitative value in remote rural areas. (C) The value of an individual in small communities. It was intended to see the singularities from southern Europe. In addition, the contributions to the processes of social recomposition and gentrification of Professor Phillips and others are very relevant^[49,50]. In particular the contributions from “the restructuring of social imaginations in rural geography” to “comparative ruralism and ‘opening new windows’ on gentrification”.

A new way to live in a rural place is a permanent vision in the analysis of newcomers. The rural area is perceived as an ideal environment to continue a professional career. Consequently, one could possibly argue in favor of a degree of association between the emergence of new social groups and the environmental issue, especially in Southern Europe, where these two phenomena are clearly linked^[51,52].

With dispersed newcomers, the value of the interview is an adequate methodological orientation. The interview, with an autobiographical character, can be segmented into three main areas: Considerations about the environment; professional implications

of the rural environment; and relationships with the community. Semi-structured interviews have been frequently used as an information source in works about social change and counter-urbanization processes, and have been described as an appropriate technique with which to study these phenomena.

A special value and originality of the wider geographical area for the social class analysis is a consequence of the research. In southern Europe, where there is less research into the new middle classes and the rural environment with its different characteristics to the north/central European countryside: Lower density and more spatial dispersion of this social group^[47,48,51,52].

In relation to the micro place, rural environment and new social groups, the following classification can be made^[51] (**Figure 3**): (1) A regressive social fraction of professional middle-class group, with a territorialized work activity. (2) A progressive social fraction of professional middle-class group, with a completely free choice of residence—spatial freedom—who choose to live in a rural location mainly because of an idealized view of the rural environment. (3) A progressive social fraction of the group of new middle classes who can (re)orientate their activity in rural areas in the framework of environmental activities and who integrate environmental considerations in their professional activity.

Among the new middle-class groups there is a notable convergence in their consideration of the rural environment as (a) a physical environment, (b) a mixture of different factors and (c) of its influence on the profession^[51,52]. The rural environment is a distinction or exclusive factor, particularly in relation to the environment’s impact on occupation. But it is more difficult to establish segmentations related to the perception of the environment, where the differences are based on secondary categories or aspects and not in binary terms (**Figure 4**).

The specific role of the new middle classes in depopulated and marginal rural settings in Southern Europe aims to further analyses: (A) the interactions between fractions of new middle classes and the rural environment, (B) the depopulation and margin-

alization can contribute to social differentiation and the individual trajectories? Associated more with key groups (interviews) than with places (experimental)? (Figure 4).

3.2 Experimental research with old social groups: Resistance and permanence

The geographical context is the new role of remote rural areas on a wider or regional scale in the spatial, political and social dimensions. The main object of research is the permanence in the same place of farmers in remote and marginal rural areas.

The variable and multiple cultural dimensions of farmers, suggest deconstructing and individualizing responses to micro processes of change and marginalization in remote rural areas. The qualitative methodology is based on biographical and ethnographical stories ^[53] of farmers who have always lived in depopulated areas ^[54,55]. The analysis of discourses can be used to study the lifestyle and complexity of some groups of farmers and to study strategies of resistance and permanence in place. Oral histories have also been used to study the different farming cultures and processes of change ^[56-58].

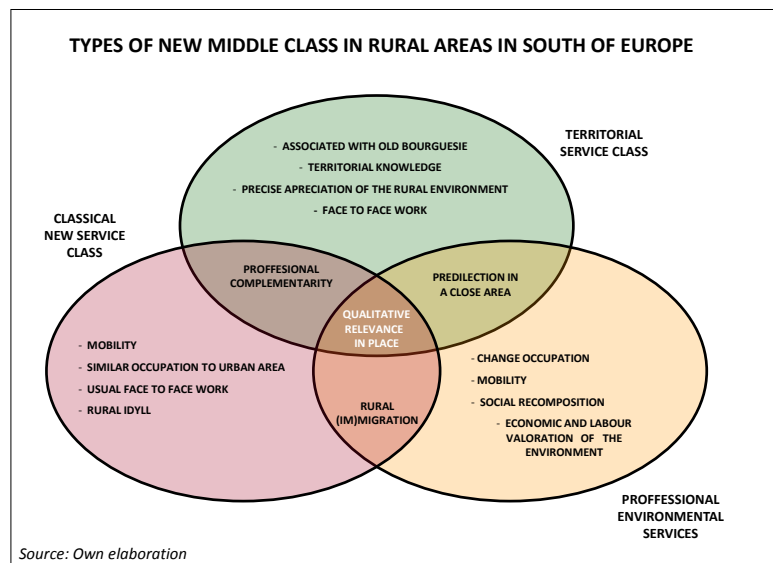


Figure 3. Types of new middle class in rural areas in South of Europe.

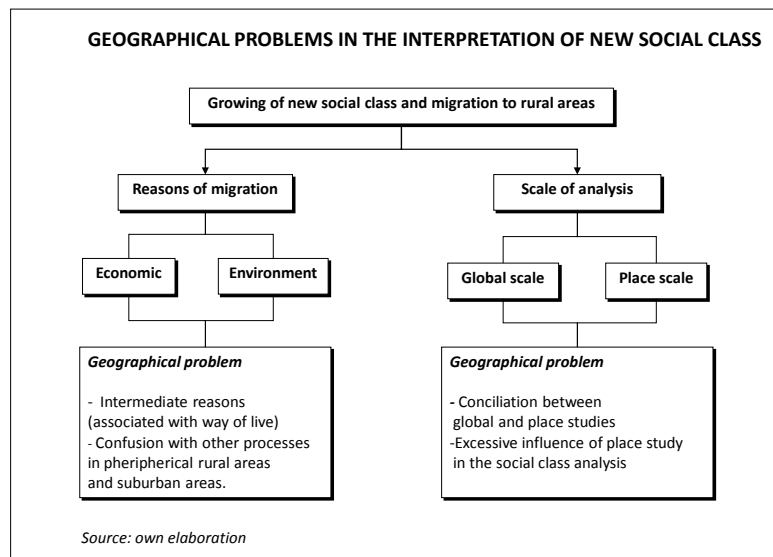


Figure 4. Geographical problems in the interpretation of new social class.

These resistance processes have a long-lasting nature, associated with a gradual and relative spatial marginalization and a transformation of the social and professional position in the context of the social community^[54,55]. Ultimately, it is possible to establish micro differences between two processes: (1) of change and resistance that confer a degree of individuality too, (2) each new situation of stability or resilience, after the depopulation process has finished. It is also possible to observe how, in several ways, the processes of change and resistance adopt an individualized dimension.

3.3 Experimental research in remote places

In this phase the works Cresswell's "In Place/Out of Place" and Agnew are relevant, but above all the reflections suggested by the contributions of Professor Halfacree's "Rural space: Constructing a three-fold architecture"^[59-61].

The initial assumption is the moral dimension of a remote place. Place and social composition suggest multiple possibilities of research around the intrinsic or singular value of the singularities (and commonalities) of each micro place. The researcher decides the most adequate route for qualitative research, between spectrums of possibilities^[62,63].

The relevance of micro and experimental research is the adequate methodology in this phase: Interview and stay in the area of few people. The constructions of facts found the work in some places but not in others^[1]. A key consideration is the relevance of the effectiveness of selections of research places^[62-64].

The main problems in the fieldwork are: (1) The (initial) distrust of the outside and civil servant: The path from distrust to participation. My social and personal position was perceived in a number of different ways by participants—in some cases with distrust—and impacted the results of the research^[65]. (2) The micro conflicts in the research area: People and micro identities. The changeable micro positionality of research and researcher in time is a relevant factor of consideration in fieldwork. (3) The influence in the qualitative research of marginality in the personal lives of people^[64].

The difficulty of the research is the marginality of the researcher in the marginal research area. The problem of living with continuity in the marginality by the researcher suggests a/the moral life of the researcher, in this perspective the researcher as others in the research area suggest new identity relations. In this context, a vision of the double otherness of the researcher emerges: For the community and for the outer or external world. The extended stay in the research area is associated with successive changes in the positionality of the researcher: Marginality as a relative and individual concept.

4. Experimental research in remote places

The live and personal experiences have four dimensions: (1) Researcher's perceptions of rural changes. (2) Personal experiences. (3) Personal life. (4) Emotional dimension of research in remote rural areas.

4.1 Research perceptions of rural change

Simple perceptions of (innovation) and changes in remote rural areas are mainly: (1) Improve in the materiality of remote rural areas: rural roads and accommodation, internet... (2) Progressive loss of the sense of community. Feelings of fatality, uncertainty... (3) Changes in the touristic and recreational use of sites^[66,67]. The antirural idyll in remote rural areas: The loss of authenticity and damages in the rural heritage and environment. (4) Changes in social dynamics, increased mobility, and the recent relevance of new-new comers. (5) Changes in mentality, from resignation to awareness of individual and social rights. This perception changes with time in a fluid and open interaction research-researcher.

4.2 Personal experiences

In a way from new binary relation to hybrid relation with the research in the process of reconciliation (or distantiation) with the participants: (A) Changes in the (co)evolution of personal/scientific

life and its influence in the fieldwork. The coevolved of researcher and fieldwork: the intersections of life events and fieldwork^[7]. (B) The self of the researcher as part of the continuity of research life process: From the initial enthusiasm of the young geographer to the “fear” of research in marginal areas in middle age. Besides, a biographical way from rural idyll to anti rural-idyll visions is mainly associated with the consequences of the 2008 global crisis in the form of “the anxiety of local populations”. (C) Personal experiences of place relate to the extreme process of depopulation^[15]: Distrust of the interviewee and the problems of the dispersion and concentration of the interviewees. Interview and going and return, with many kilometers, by the distance between participants in the research.

Two sides in my personal experiences (material and spiritual/emotional): (1) Personal experiences in remote rural areas in relation to innovations and improvements: (tele) Communications, innovations, well-being... A double circuit in my personal vision: Improve the conditions of research and loss of authenticity. The improvements in local roads and accommodation—a result of rural tourism programs—offer material security in the fieldwork. (2) Spiritual or emotional considerations: (a) Reconsideration of personal and professional aspirations. Lessons from the subject of research: The authenticity of local people. (b) Need to connect the research with the improvement of the daily life of participants (the essential utility of research).

4.3 Personal life and the approach to marginal research area

Laboratory life as research is not an autobiography (the self) is the continuity in the relationship between the researcher and researcher. In this sense, fieldwork and life course are interrelated^[7]. Personal experiences of place related to larger processes^[15] are very relevant in the production of qualitative subjectivity. In my own experience I had positive emotions with depopulated areas before the pleasure of staying and researching. Many times, when I returned from the fieldwork, a feeling of longing

overwhelmed me, towards the places and the people I was investigating.

The individual trajectory in qualitative research suggests two main sides: Feelings and activism. (A) Personal feelings to: (1) Newcomers, courageous and determined people—respect —people with the capacity to decide to change their life, they urged you to take the step and stay to live in a depopulated rural area. The relevance of micro place of newcomers: Homes, houses, villages^[68,69]. (2) Old populations, the spirit of resistance in place, identity with my place, my land, my landscape^[70-74]. Specifically, I was always affected by the skepticism of farmers and interview schedules “This is over”, sometimes very late and both tired. (B) Personal activism in local spheres and national newspapers.

4.4 Emotional dimension of the research in remote rural areas

The life events and emotions of a researcher affect the research process^[21]. The relevant role of emotions in (qualitative) research^[8,7], is a common, but variable element of qualitative research. The isolation of researchers in remote rural areas is an additional dimension of geo-ethnographic work, as it is carried out in aggressive environments, relative to the harshness of the socio-environmental context. In small communities, it is necessary to have a certain ability and personal fortitude to integrate temporarily and observe. Distance and friendly with participants are an equilibrated relationship: “The research participant’s involvement in fieldwork can constitute a professional engagement as well as a personal one”^[8]. There is an emotional dimension of fieldwork, with the personal feeling of depopulation and remoteness. Furthermore, personal feelings of distance and “remoteness” arise in relation to bureaucratized research structures (and the research institute). Is one of the main consequences of the (negative) “relevance” of institutions in fieldwork research? The pressures of results and qualitative research do not have a good relationship. The research project represents the time for speed results of field work.

The bureaucratic problems with the fieldwork and

its relevance in qualitative experimental research are key questions with time. In my laboratory life experience fieldwork, is a personal gateway in many moments to institutional work. The progressive preference by deep qualitative methods is associated with a/the moral dimension of everyday life (or researcher) in depopulated areas: Problems with diet and tendency to gain weight, emotionality with participants, social barriers in the research area, loneliness, inner peace (and tranquility) of researcher.

In what my research work helps these people? It is a personal question in my professional career. My answer: The collaboration between national newspapers and political advice. My final recommendation: Slow and inclusive final change for depopulated rural areas (2021-2022).

5. Conclusions

Laboratory life reflects the permanent relationship of a researcher with a study subject over a long period of time, of about 20 years in the author's experience. Research is usually based on the results, but not on the lives and emotions of the people who build, design, research and write them. The impact of life in qualitative research is a relevant factor in the production of qualitative and (geo) ethnographic information^[75]. Changes in life and emotions impact the form and focus of the investigation. The researcher's life cycle is associated with the emotional dimension of qualitative research.

Establishing laboratory life as a work strategy also allows for increasing the rigour of qualitative research and its scalar dimension in order to expand the spatial validity of its results. As there is a very long-term strategy, it is possible to combine different phases in order to increase the validity of the results. In our case, it has consisted of combining mobility, with resistance and the politics of places, of traditional and new populations in rural areas, in order to better establish the social effects of rural change processes. This research is linked to the life trajectory of the researcher and is unrepeatable, both in their execution and in their published results where deep causal relationships are disseminated, which

little change over time. The results of laboratory life research can only be supported or not by other scientific publications in other parts of the world. This is the fundamental value of a work strategy founded on experimental qualitative work as a vital experience.

Conflict of Interest

There is no conflict of interest.

References

- [1] Latour, B., 1986. *Laboratory life. The constructions of scientific facts*. Princeton University Press: Princeton.
- [2] Johnston, R., Hepple, L., Hoare, T., et al., 2003. Contemporary fiddling in human geography while Rome burns: Has quantitative analysis been largely abandoned—and should it be? *Geoforum*. 34(2), 157-161.
- [3] Robinson, G., 1998. *Methods and techniques in human geography*. John Wiley and Sons: London.
- [4] Hay, I., 2003. *Qualitative research methods in human geography*. Oxford University Press: Oxford.
- [5] Valentine, G., 2006. Relevance and rigour: The advantages of reusing and scaling up qualitative data. *Environment and Planning A*. 38, 413-415.
- [6] Baxter, J., Eyles, J., 1997. Evaluating qualitative research in social geography: Establishing 'rigour' in interview analysis. *Transactions of the Institute of British Geographers*. 22(4), 505-525.
- [7] Wimark, T., Lewis, N.M., Caretta, M.A., 2017. A life course approach to the field and fieldwork. *Area*. 49(4), 390-393.
- [8] Lewis, N.M., 2017. Linked life courses in fieldwork: Researcher participant and field. *Area*. 49(4), 394-401.
- [9] Massey, D., 2005. *For space*. Sage: London.
- [10] Murdoch, J., 2006. *Post-structuralist geography*. Sage: London.
- [11] Leitner, H., 2012. *Spaces of encounters: Immigration, race, class, and the politics of belonging*

- in small-town America. *Annals of the Association of American Geographers*. 102(4), 828-846.
- [12] Willet, J., 2023. Place-based rural development: A role for complex adaptive region assemblages? *Journal of Rural Studies*. 97, 583-590.
- [13] Cloke P., Johnston, R. (editors), 2005. *Spaces of geographical thought*. Sage: London.
- [14] Gregory, D., 1994. *Social theory and human geography*. Human geography: Society, space and social science. McMillan Press: London. pp. 78-112.
- [15] Butz, D., Besio, K., 2009. Autoethnography. *Geography Compass*. 3(5), 1660-1674.
- [16] Gold, L., 2002. Positionality, worldview and geographical research: A personal account of a research journey. *Ethics, Place & Environment*. 5(3), 223-237.
- [17] Fisher, K.T., 2015. Positionality, subjectivity, and race in transnational and transcultural geographical research. *Gender, Place & Culture*. 22(4), 456-473.
- [18] Kusek, W.A., 2014. Navigating the city: Gender and positionality in cultural geography research. *Journal of Cultural Geography*. 31(2), 152-165.
- [19] Wickramasingha, S., 2023. Constructing (im)perfect geographical knowledge: Negotiating positionality in comparative sites. *The Professional Geographer*. 1-11.
- [20] Elder, G.H., Johnson, M.K., Crosnoe, R., 2003. The emergence and development of life course theory. *Handbook of the life course*. Kluwer Academics: New York. pp. 3-19.
- [21] Ng, I., 2017. When [inter]personal becomes transformational: [re-]examining life course-related emotions in PHD research. *Area*. 49(4), 409-414.
- [22] Shaw, S.W., 2013. Auto-ethnography and autobiography in geographical research. *Geoforum*. 46, 1-4.
- [23] Fois, F., 2017. Understanding ethnography through a life course framework: A research journey into alternative spiritual spaces. *Area*. 49(4), 421-428.
- [24] Davidson, J., Bondi, L., Smith, M. (editors), 2005. *Emotional geographies*. Routledge: London.
- [25] Hay, I., 2003. *Qualitative research methods in human geography*. Oxford University Press: Oxford.
- [26] Cloke, P., Cooke, P., Cursons, J., et al., 2000. Ethics, reflexivity and research: Encounters with homeless people. *Ethics, Place and Environment*. 3(2), 133-154.
- [27] Careta, M.A., Cheptum, F.J., 2017. Leaving the field: (de-)linked lives of the researcher and research assistant. *Area*. 49(4), 415-420.
- [28] Gambold, L.L., 2017. Maybe you will remember: Interpretation and life course reflexivity. *Area*. 49(4), 402-408.
- [29] Hooks, B., 2014. *Feminist theory: From margin to center*. Routledge: London.
- [30] Hoggart, K., Lees, L., Davies, A., 2002. *Researching human geography*. Arnold: London.
- [31] Crang, M., 2003. *Telling materials. Using social theory: Thinking through research*. Sage: London. pp. 127-144.
- [32] Paniagua, A., 2017. The (lost) life of a historic rural route in the core of Guadarrama Mountains, Madrid (Spain). A geographical perspective. *Landscape History*. 38(1), 81-94.
- [33] Murdoch, J., Marsden, T., 1996. *Reconstituting rurality*. UCL Press: London.
- [34] Hoggart, K., Paniagua, A., 2001. The restructuring of rural Spain? *Journal of Rural Studies*. 17, 63-80.
- [35] Paniagua, A., 2000. Analysis of the evolution of farmers' early retirement policy in Spain. The case of Castille and Leon. *Land Use Policy*. 17(2), 113-120.
- [36] Paniagua, A., 2001. Agri-environmental policy in Spain. The agenda for socio-political developments at the national, regional and local levels. *Journal of Rural Studies*. 17, 81-97.
- [37] Buller, H., Wilson, G., Holl, A., 2000. *Agri-environmental policy in the European Union*. Ashgate: London.
- [38] Cloke, P. J., Doel, M. A., Matless, D., et al., 1994. *Writing the rural: Five cultural geogra-*

- phies. Paul Chapman Publishing: London.
- [39] Cloke, P., Little, J. (editors), 1997. *Contested countryside cultures: Otherness, marginalisation and rurality*. Routledge: London.
- [40] Deleuze, G., 1994. *Difference and repetition*. Columbia University Press: New York.
- [41] Valentine, G., 2008. Living with difference: Reflections on geographies of encounter. *Progress in Human Geography*. 32(3), 323-337.
- [42] Elwood, S.A., Martin, D.G., 2000. "Placing" interviews: Location and scales of power in qualitative research. *The Professional Geographer*. 52, 649-657.
- [43] Dunn, K., 2003. Interviewing. *Qualitative research methods in human geography*. Oxford University Press: Oxford. pp. 50-82.
- [44] Cloke, P., Phillips, M., Thrift, N., 1995. The new middle class and the social construction of rural living. *Social change and the middle classes*. UCL Press: London. pp. 220-238.
- [45] Hoggart, K., 1997. The middle classes in rural England 1971-1991. *Journal of Rural Studies*. 13(3), 253-273.
- [46] Hoggart, K., 2007. The diluted working classes of rural England and Wales. *Journal of Rural Studies*. 23(3), 305-317.
- [47] Paniagua, A., 2002. Counterurbanization and new social class in rural Spain: The environmental and rural dimension revisited. *Scottish Geographical Journal*. 118(1), 1-18.
- [48] Paniagua, A., 2002. Urban-rural migration, tourism entrepreneurs and rural restructuring in Spain. *Tourism Geographies*. 4, 349-372.
- [49] Phillips, M., 1998. The restructuring of social imaginations in rural Geography. *Journal of Rural Studies*. 14, 121-153.
- [50] Phillips, M., Smith, D.P., 2018. Comparative ruralism and 'opening new windows' on gentrification. *Dialogues in Human Geography*. 8(1), 51-58.
- [51] Paniagua, A., 2008. The environmental dimension in the constitution of new social groups in an extremely depopulated rural area of Spain (Soria). *Land Use Policy*. 25(1), 17-29.
- [52] Paniagua, A., 2008. The environment in the process of differentiation of new social fractions in depopulated areas of Spain: Key environmental considerations in the way from big cities to extreme depopulated areas. *CIDADES, Comunidades e Territórios*. 16, 31-41.
- [53] Holloway, L., 2002. Smallholding, hobby-farming, and commercial farming: Ethical identities and the production of farming spaces. *Environment and Planning A*. 34, 2055-2070.
- [54] Paniagua, A., 2014. Perspectives of livestock farmers in an urbanized environment. *Land*. 3, 19-33.
- [55] Paniagua, A., 2019. Farmers' resistance in urbanised and remote rural places: A geographical perspective. *Rural Society*. 28, 15-28.
- [56] Besio, K., 2020. *Autoethnography*. International encyclopedia of human geography (second edition). Elsevier: Amsterdam.
- [57] Cragg, M.A., 2007. *Doing ethnographies*. Sage: London.
- [58] Willianson, K., 2018. *Ethnographic research. Research methods: Information, systems and contexts (second edition)*. Elsevier: Cambridge. pp. 311-335.
- [59] Cresswell, T., 1996. *In place/out of place. Geography, ideology and transgression*. University of Minneapolis Press: Minneapolis.
- [60] Agnew, J., 2015. *Place and politics. The geographical mediation of State and society*. Routledge: London.
- [61] Halfacree, K., 2006. Rural space: Constructing a three-fold architecture. *Handbook of rural studies*. Sage: London. pp. 44-62.
- [62] Paniagua, A., 2009. The politics of place: Official, intermediate and community discourses in depopulated rural areas of Central Spain. The case of the Riaza river valley (Segovia, Spain). *Journal of Rural Studies*. 25(2), 207-216.
- [63] Paniagua, A., 2015. Geographical trajectories, biographical determinants and (new) place political elites in selected remote rural areas of north-central Spain. *The Geographical Journal*. 181(4), 401-412.

- [64] Paniagua, A., 2017. Spatial and individual resistance(s) in depopulated and remote rural areas. *Space and Polity*. 21, 303-317.
- [65] Paniagua, A., 2020. Alternative communities in rural spaces. A world of others. *Researches Reviews of the Department of Geography, Tourism and Hotel Management*. 49(1), 51-69.
- [66] Paniagua, A., 2012. The rural as a site of recreation: Evidences and contradictions in Spain from a geographical perspective. *Journal of Tourism and Cultural Change*. 10, 264-275.
- [67] Paniagua, A., 2016. New rurality, events and festivals in selected places of rural Spain. *Social Studies*. 2, 113-129.
- [68] Paniagua, A., 2010. I live out in the countryside. Exploring extreme processes of individualization in rural Spain. *Scottish Geographical Journal*. 126(1), 9-23.
- [69] Paniagua, A., 2016. An individual rural geography. *The Professional Geographer*. 68(3), 511-518.
- [70] Paniagua, A., 2014. Rurality, identity and morality in remote rural areas in Northern Spain. *Journal of Rural Studies*. 35, 49-58.
- [71] Paniagua, A., 2018. Local people unprotected by protected (depopulated) natural areas: The case of Sierra Norte Guadalajara, Spain. *Geojournal*. 83(5), 993-1004.
- [72] Bryant, R.L., Paniagua, A., Kizos, T.H., 2011. Conceptualising 'shadow landscape' in political ecology and rural studies. *Land Use Policy*. 28, 450-471.
- [73] Paniagua, A., 2013. Farmer living in remote rural areas: The worth of permanence in the place. *Land Use Policy*. 35, 1-7.
- [74] Paniagua, A., 2019. Encounters in the valley: Love and emotions in microprocesses of gentrification in depopulated rural areas. *Geojournal*. 84, 471-481.
- [75] McGarrol, S., 2017. The emotional challenges of conducting in-depth research into significant health issues in health geography: Reflections on emotional labour, fieldwork and life course. *Area*. 49(4), 436-442.

ARTICLE

Spatio-temporal Heterogeneity in the Performance of Rural Revitalization in Chifeng City of China: Based on a Range-wide EBM-GML Model

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ABSTRACT

To solve the problems of rural revitalization performance research, a quantitative model of non-oriented range-wide EBM (Epsilon-Based Measure)-GML (Global-Malmquist) based on VRS (Variable Returns to Scale) conditions including non-desired outputs is constructed. A comprehensive spatio-temporal heterogeneity research index system of rural revitalization performance is also constructed. Taking the typical rural in Chifeng City as an example, the panel data from 2016-2020 are selected for empirical analysis, the conclusions and countermeasures are suggested as follows: 1) In general, the rural revitalization performance of Chifeng City increases significantly during the five-year period, with significant spatio-temporal heterogeneity. The overall analysis shows that the overall performance value of rural revitalization in Chifeng City is 0.683 from 2016 to 2020. The highest performance value is 1 and the lowest performance value is 0.389. The performance growth rate increases year by year, with an average annual growth rate of 4.46%. 2) From 2016 to 2020, the GML index of rural revitalization performance in Chifeng City is 1.174, showing an increasing trend. Based on the range of change of GML index, Chifeng City can be classified into three types: Continuous improvement, fluctuating improvement and fluctuating decline. 3) Niujiayingzi, Guandongche, Zhaidamu, and Qiangangtai rural have the highest degree of technological progress.

Keywords: Rural revitalization; Performance; EBM model; GML index; Spatio and temporal heterogeneity; Chifeng City

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1. Introduction

Since the rural revitalization strategy is proposed, rural development has received wide attention and rural revitalization has become a research hotspot^[1]. The implementation of a rural revitalization strategy will definitely inject a strong impetus into the development of rural China^[2]. The performance assessment of rural revitalization provides valuable guidance, a standard system and social momentum for achieving the goals of rural revitalization planning^[3]. Currently, it is a critical period for the implementation of the rural revitalization strategy^[4]. To further promote the strategic planning of rural revitalization, we should solve realistic problems, make up for the shortcomings of people's livelihood, and strengthen incentives to continuously improve the assessment system^[5].

Therefore, this paper takes a problem-oriented approach, constructs a spatio-temporal heterogeneity research index system of rural revitalization performance, and builds a range-wide EBM-GML mathematical model. Select 12 typical rural of Chifeng City as research objects to understand the development of rural revitalization in different regions and assess the regional imbalance problems in the implementation of rural revitalization, which is very important for assessing the rural performance of other regions.

2. Literature review

The literature review is conducted in terms of rural revitalization and rural revitalization performance study by using Citespace to analyze the keyword co-occurrence network of related literature from 2002-2021.

2.1 Rural revitalization

(1) Theoretical research. In addition to policy revitalization and institutional revitalization, international rural revitalization research hotspots involve sociology, economics, urban and rural planning, geography, ecology and other multidisciplinary fields,

including talent revitalization, cultural revitalization and organizational revitalization. De Janvry A proposed that organizational revitalization should make policy maximize^[6]. Korsching P established a rural cultural revitalization management system^[7]. Hilary Tovey and Carr P J proposed a talent revitalization framework to guide rural construction^[8,9]. National studies are mainly in the fields of urban and rural planning, geography, and architecture, including paths and strategies for cultural revitalization, ecological revitalization, and industrial revitalization. Huang Juan et al. explored German rural planning and inspired rural revitalization in China^[10]. Zhang J. interpreted the "maintain and update" in rural cultural revitalization^[11]. Luo Zhendong et al. pointed out the path of rural cultural revitalization in the era of mobile Internet^[12]. Fan Lingyun et al. proposed an ecological planning strategy for rural revitalization^[13]. Chen Qianhu and Zhao Yi et al. proposed a high-quality revitalization path for rural industries^[14,15].

(2) Practice research. Most international practices for rural revitalization are focused on industrial revitalization and ecological revitalization. Kawate T and Irwin E G discussed different types of rural industries and categorized them for planning^[16,17]. Nonaka A summarized the practice and history of rural ecological revitalization^[18]. Li Z introduced rural planning and development^[19]. National practices for rural revitalization are mostly focused on rural construction planning. Zhang Rulin et al. explored the practice of rural revitalization planning in urban suburban areas^[20]. Gala Xiaojun et al. explored rural construction planning under the implementation orientation of rural revitalization strategy^[21].

2.2 Research on the performance of rural revitalization

International research on the performance of rural revitalization has gradually become research hotspots in multiple fields such as ecology and environment, economics, geography and anthropology along with the development of modern science in the West. Scholars mostly adopt quantitative analysis methods such as DEA (data envelopment analysis), system

analysis model, and data analysis model. Hodge I used the DEA model to assess typical rural [22]. Nemes G proposed an integrated and non-integrated system analysis model of rural revitalization [23]. María-Angeles Díez et al. added the application of rural revitalization data analysis models in performance assessment [24]. In contrast, national rural revitalization performance research start late, and although the overall number of research results show a trend of increasing year by year, they are mostly theoretical exploration based on their own disciplinary backgrounds, and interdisciplinary cross-sectional research is weak. The overall research is at the stage of theoretical system construction, and the practical application is slightly insufficient. Scholars mostly adopt qualitative analysis methods such as screening analysis, cluster analysis, hierarchical analysis, and principal component analysis, and the research perspectives are mainly focused on rural party organization, cultural governance, and rural tourism. Ji, C. Q. established a rural organization revitalization performance system [25]. Ma Xuejun and Wang Fujian et al. established a rural cultural revitalization performance system [26,27]. Yuan Chen et al. established a rural tourism revitalization performance system [28]. Zhang Q and Yang Xue construct a performance evaluation index system for rural revitalization in China [29,30].

In summary, scholars of national and international have made some achievements in the study of rural revitalization performance using different research methods and from different perspectives, which enrich the connotation and theoretical methods of rural revitalization. It is of reference significance for the comprehensive study of rural revitalization performance.

2.3 Problems of national and international research

Through national and international studies, it is found that there are still some problems in the research on the performance of rural revitalization by national and international scholars. 1) Research objects. Usually, performance research is from one as-

pect, such as rural tourism performance, rural party organization performance, rural cultural governance performance, etc. There is a lack of holistic and systematic research on rural revitalization performance.

2) Research methods and model selection. Most of the research methods adopt principal component analysis and hierarchical analysis, which are assigned by experts, and the analysis results are more subjective and lack objectivity. The model mostly adopts the traditional DEA model, which has the disadvantages of not considering the non-desired output, limiting the radial measurement, poor precision and poor interpretation. 3) Construction of indicator system. The literature review reveals that the index system of national performance research is not theoretically based on national policies, and is mostly constructed according to the five aspects of the strategic objectives of rural revitalization or according to the *Strategic Plan for Rural Revitalization (2018-2022)* with few far-sightedness and scientificity. Meanwhile, input indicators and output indicators are selected with few ranges and small numbers; only hard indicators of quantitative description are considered, and soft indicators of qualitative description are ignored; only desired outputs such as economic development are considered, and non-desired outputs such as destruction and demolition are ignored. 4) Data selection. The data are usually cross-sectional data without considering time series, which cannot reflect the dynamic changes in rural revitalization performance over time. These shortcomings lead to the inability to assess the overall rural revitalization systematically, comprehensively and dynamically.

3. Realistic problems and contributions of this paper

3.1 Realistic problems

Through field research, the real problems are as follows:

(1) Fractured cultural inheritance and insufficient preservation awareness in the rural. The key to rural as another type of cultural heritage is its liveliness, that is to say, it is still alive and has the possibility

of continuation. However, rural culture faces the dilemma of fractured inheritance, and the phenomenon of “hollowing out” of cultural development is extremely serious. The problem of destruction and demolition of historical and cultural heritage is serious. There is a lack of revitalization and utilization of historical and cultural heritage, an insufficient manifestation of humanistic characteristics, fewer supporting resources for rural cultural construction, and fewer cultural theme activities.

(2) The construction of rural talent is poor, and cadres are not competent enough. First of all, the number of rural leaders and cadres, technicians and basic managers is insufficient, and the construction of a talent team needs to be improved. The number of party members in the rural is small, and the percentage of young party members is low. Secondly, the cadres' ability is insufficient. Localities take various ways to organize rural cadres to visit and study in advanced areas, but cadres touch less on professional skills such as project selection, implementation and support, resulting in a lack of relevant project management experience and fear of appraisal and accountability for work mistakes.

(3) The level of industrial construction in rural is seriously different. Rural industrial revitalization in general presents differentiation. Different degrees of local policy inclination lead to different levels of rural industrial construction in each region. The industrial models are different, and there is a large gap in the momentum of the integration of agriculture and travel. The lack of integrated industrial chains leads to insufficient construction of the overall industrial chain for regional rural revitalization, making it difficult to bridge the realistic gap and form a synergized industrial model.

(4) Lack of linkage in rural revitalization and different management levels. The distribution characteristics and linkage features of the rural intensify the differentiation of the regional rural, and the overall rural revitalization of the region is not strong enough and the management level is different. The distribution pattern of large dispersion and small agglomeration and the graded development trend

makes it difficult to break multiple realistic barriers and form a unified and linked management model in rural revitalization in the face of natural and authority boundaries by natural landscape boundaries and regional jurisdictions.

3.2 Contribution of this paper

In order to solve the problems of rural revitalization performance research, this paper constructs a comprehensive index system for the study of spatio-temporal heterogeneity of rural revitalization performance and builds a range-wide EBM-GML mathematical model, which can comprehensively, objectively and accurately assess the dynamic implementation performance of rural revitalization. The contributions are as follows: 1) The index system is farsightedness and scientific. The literature review reveals that the index system of national performance research is not theoretically based on national policies, and is mostly constructed according to the five aspects of the strategic objectives of rural revitalization or according to the *Strategic Plan for Rural Revitalization (2018-2022)*, while the index system of this study is theoretically based on the latest national policies, which is more farsighted and scientific. The spatio-temporal heterogeneity research index system of rural revitalization performance, which contains 13 primary indicators, 20 secondary indicators and 36 tertiary indicators, is constructed based on the principles of systematicity, comprehensiveness, scientificity, operability and coordination. It strives to measure the overall dynamic implementation performance of rural revitalization in a comprehensive and multi-perspective way. 2) Innovate research methods. A non-oriented range-wide EBM-GML model based on VRS conditions and containing non-desired outputs is constructed. It contains both radial and non-radial directional distance functions, which can be projected to the strongly effective production frontier surface. Consider the non-desired output, and thus the study of rural revitalization performance is more comprehensive, objective, scientific and precise. Meanwhile, combined with the global reference GML index, it can reflect the impact of time change

on rural revitalization performance. 3) Dynamic data selection. The panel data from 2016-2020 are selected by considering the time series comprehensively to realize the dynamic measurement of rural revitalization performance.

4. Method: Model construction

4.1 EBM model

The reason why the EBM model is used in this paper instead of traditional DEA is that the advantages of the EBM model over traditional DEA are: 1) EBM model considers non-desired output, which makes the indicator system more comprehensive, while DEA does not consider non-desired output and the indicator system is not comprehensive enough. 2) The EBM model includes both radial and non-radial projections, which is optimal and most effective. While the traditional DEA selection is limited to radial measures^[31], this radial projection to the effective frontier surface is not optimal or most effective, and all inputs or outputs of the non-effective decision unit must be reduced or enlarged according to the same proportion before they become relatively effective^[32]. 3) The EBM model is more explanatory and more accurate than DEA after adding the second-order interaction term. The EBM model includes both radial and non-radial directional distance functions as shown in Equation (1).

$$\begin{aligned} \rho^* &= \min \theta - \varepsilon_x \sum_{i=1}^m \frac{w_i^- s_i^-}{x_{ijo}} \\ \text{s.t. } \sum_{j=1}^n x_{ij} \lambda_j + s_i^- &= \theta x_{ijo}, i = 1, \dots, m \\ \sum_{j=1}^n y_{ej} \lambda_j &\geq y_{ejo}, e = 1, \dots, p \\ \sum_{j=1}^n \lambda_j &= 1 \\ \lambda_j &\geq 0, s_i^- \geq 0 \end{aligned} \quad (1)$$

ρ^* denotes the efficiency value of the EBM model with variable returns to scale. $0 \leq \rho^* \leq 1$. θ is the radial parameter. w_i^- is the value of the i importance

of the input, $\sum_{i=1}^m w_i^- = 1$. s_i^- is the slack variable for the type i input. x_{ijo} is the type i input of the j_o decision unit, with a total of m inputs. y_{ejo} is the type e output of the j_o decision unit, with a total of p outputs. λ is the degree of importance of the reference decision unit. ε_x is the combined parameter of the radial θ and non-radial slack variables, equal to 0 is equivalent to the radial model and equal to 1 is equivalent to the SBM model.

Since non-desired outputs such as ineffective preservation, ineffective management, and social assistance are involved, it is also considered that both input and output indicators can be projected radial or non-radial. For this reason, Equation (1) is extended to construct an undirected EBM model based on the VRS condition with non-desired outputs included. This is shown in Equation (2). The model includes non-desired outputs, and also includes proportional and slack projections, which can be projected onto the strong effective frontier surface, that is to say the optimal production frontier surface, thus making the performance of rural revitalization more comprehensive, scientific and accurate.

$$\begin{aligned} E(x_{jo}, y_{jo}, z_{jo}) &= \rho^* \\ &= \min \frac{\theta - \varepsilon_x \sum_{i=1}^m \frac{w_i^- s_i^-}{x_{ijo}}}{\varphi - \tau + \varepsilon_y \sum_{e=1}^p \frac{w_e^+ s_e^+}{y_{ejo}} + \varepsilon_z \sum_{u=1}^q \frac{w_u^- s_u^-}{z_{ujo}}} \\ \text{s.t. } \sum_{j=1}^n x_{ij} \lambda_j + s_i^- &= \theta x_{ijo}, i = 1, \dots, m \\ \sum_{j=1}^n y_{ej} \lambda_j - s_e^+ &= \varphi y_{ejo}, e = 1, \dots, p \\ \sum_{j=1}^n z_{uj} \lambda_j + s_u^- &= \tau z_{ujo}, u = 1, \dots, q \\ \sum_{j=1}^n \lambda_j &= 1 \\ \lambda_j &\geq 0, s_i^- s_e^+, s_u^- \geq 0 \end{aligned} \quad (2)$$

where E is the directional distance function under the VRS condition, and z_{ujo} is the type u non-desired output of the j_o decision unit. w_e^+ is the importance

of the type e desired output. s_e^+ is the type e desired output slack variable. w_u^- is the importance of the type u non-desired output. s_u^- is the type u non-desired output slack variable.

4.2 GML index

The ML (Malmquist) index solves this problem. However, the ML index suffers from the problem of no feasible solution under VRS conditions. For this reason, an overall reference Malmquist index, the GML index method is used [41]. It uses the sum of all periods as the reference set. That is, the reference set common to all periods is:

$$S^g = S^1 \cup S^2 \cup \dots \cup S^p = \{(x_j^1, y_j^1)\} \cup \{(x_j^2, y_j^2)\} \cup \dots \cup \{(x_j^p, y_j^p)\}$$

Since the same frontier is referenced for each period, a single Malmquist Index is also calculated.

$$M_g(x^{t+1}, y^{t+1}, b^{t+1}, x^t, y^t, b^t) = \frac{E^g(x^{t+1}, y^{t+1}, b^{t+1})}{E^g(x^t, y^t, b^t)}$$

Although the two adjacent periods refer to the same overall frontier in the calculation of the Malmquist Index, the calculation of changes in assessed values still uses the respective frontiers.

$$EC = \frac{E^{t+1}(x^{t+1}, y^{t+1}, b^{t+1})}{E^t(x^t, y^t, b^t)}$$

The closeness of frontier $t+1$ to the overall frontier can be expressed as $\frac{E^g(x^{t+1}, y^{t+1}, b^{t+1})}{E^{t+1}(x^{t+1}, y^{t+1}, b^{t+1})}$ to indicate that a larger value indicates that the frontier $t+1$ is closer to the overall frontier. The degree of proximity of frontier t to the overall frontier, can be expressed as $\frac{E^g(x^t, y^t, b^t)}{E^t(x^t, y^t, b^t)}$ to indicate the closeness of frontier t to the overall frontier. The variation of frontier $t+1$ compared to frontier t can be expressed as the ratio of two ratios.

$$TC_g = \frac{E^g(x^{t+1}, y^{t+1}, b^{t+1}) / E^{t+1}(x^{t+1}, y^{t+1}, b^{t+1})}{E^g(x^t, y^t, b^t) / E^t(x^t, y^t, b^t)}$$

The GML index can be decomposed into efficiency changes and technical changes.

$$M_g(x^{t+1}, y^{t+1}, b^{t+1}, x^t, y^t, b^t) = \frac{E^g(x^{t+1}, y^{t+1}, b^{t+1})}{E^g(x^t, y^t, b^t)} \\ = \frac{E^{t+1}(x^{t+1}, y^{t+1}, b^{t+1})}{E^t(x^t, y^t, b^t)} \left(\frac{E^g(x^{t+1}, y^{t+1}, b^{t+1})}{E^{t+1}(x^{t+1}, y^{t+1}, b^{t+1})} \frac{E^t(x^t, y^t, b^t)}{E^g(x^t, y^t, b^t)} \right) \\ = EC \times TC_g$$

Since the assessed decision unit is definitely included in the overall reference set, the overall reference Malmquist index. That is to say, the GML index does not have the problem of no feasible solution under VRS conditions. Since the reference in each period is the common overall frontier, the GML index possesses transferability and can be multiplied cumulatively.

4.3 Range-wide EBM-GML model

The non-oriented EBM model based on the VRS condition containing non-desired output is combined with the GML index to construct the non-oriented region-wide EBM-GML model based on the VRS condition containing non-desired output, as shown in Equation (3).

$$E_D^t(x_{jo}^t, y_{jo}^t, z_{jo}^t) = \min \frac{\theta - \varepsilon_x \sum_{i=1}^T \sum_{i=1}^m \frac{w_i^- s_i^-}{x_{ijo}}}{\varphi - \tau + \varepsilon_y \sum_{t=1}^T \sum_{e=1}^p \frac{w_e^+ s_e^+}{y_{ejo}} + \varepsilon_z \sum_{t=1}^T \sum_{u=1}^q \frac{w_u^- s_u^-}{z_{ujo}}} \\ s. t. \sum_{t=1}^T \sum_{j=1}^n x_{ij} \lambda_j + s_i^- = \theta x_{ijo}, i = 1, \dots, m \\ \sum_{t=1}^T \sum_{j=1}^n y_{ej} \lambda_j - s_e^+ = \varphi y_{ejo}, e = 1, \dots, p \\ \sum_{t=1}^T \sum_{j=1}^n z_{uj} \lambda_j + s_u^- = \tau z_{ujo}, u = 1, \dots, q \\ \sum_{t=1}^T \sum_{j=1}^n \lambda_j = 1 \\ \lambda_j \geq 0, s_i^-, s_e^+, s_u^- \geq 0$$

4.4 Model test

Model testing is the research and testing process to determine the correctness, validity, and credibility of a model. In this study, four types of tests are combined and the results are as follows: 1) Model structure suitability test: Consistent magnitudes, equations meet extreme conditions, and appropriate model bounds. 2) Model behavior suitability test: Parameter sensitivity and structure sensitivity are high. 3) Model structure consistency test with the actual

system: Appearance test, parameter meanings and their values are consistent. 4) Model behavior and actual system consistency test: Model behavior can reproduce the reference model, extreme behavior of the model, and simulation under extreme conditions are consistent.

5. Empirical analysis

5.1 Typical experience of rural revitalization in Chifeng City

The demonstration significance of typical experience of rural revitalization in Chifeng is focused on “organization construction as a lever to promote comprehensive rural revitalization”. In recent years, in response to the outstanding contradictions and problems of “small scale of operation, scattered production patterns and low level of industrial structure” that have long existed in rural development, Chifeng National Rural Revitalization Demonstration Zone based on the functional positioning of ecological cultured area, has started with the construction of collective economic organizations at the town and rural levels led by party building, and enhanced the level of collective economic coordination. It has completed the restructuring of the organizational system, the restructuring of the land use structure of rural, the restructuring of the industrial chain led by the union of talents, and the stimulation of the potential value of cultural resources and ecological advantage resources. The potential value of the project has been enhanced. Project funds have been integrated and connected to cultivate green and healthy vibrant rural around the key work and weak links such as industrial development and cultural construction. Great progress has been made in the construction of demonstration projects, and a practical path with exemplary significance for the comprehensive promotion of rural revitalization has been initially formed.

(1) Organizational construction. The construction of rural basic organizations has been strengthened. 87 weak and lax rural party organizations have been rectified continuously and incorporated rural affairs openness and democratic management into the or-

ganization construction. The first clerks fully played an important role in the party building and rural revitalization promotion, and the pilot task of building a national rural governance system in Yuanbaoshan District and Ningcheng County has been completed. The construction of innovative demonstration of rural-level deliberation and consultation has been carried out.

(2) Industrial development. Expanded the multiple functions of agriculture, tapped the multiple values of the rural, and continuously improved the quality and efficiency of rural modern agriculture. It has created modern agricultural parks, increased the organization of farmers’ participation in industrial operations, and promoted the integration of rural industrial projects with science practice and study education.

(3) Ecological preservation. It has promoted the green development of agriculture and rural areas. The carbon sink capacity of rural forest resources increased by 150,000 tons, and the forest coverage rate reached over 40.7%. The strategic white temporary greening of 883 hectares has been implemented. A national ecological civilization construction demonstration area and “green water and green mountains is the silver mountain” practice innovation base has been created. The construction of national agricultural green development pioneer areas in Hongshan District and Songshan District has been promoted.

(4) Cultural prosperity. The cultural resources of the rural have been fully explored. The Chinese Farmers’ Harvest Festival Chifeng celebration, Chifeng Farmers’ Art Festival, other festive folklore activities and mass cultural activities have been widely carried out. Cultural excavation and preservation have been promoted, organized rural material and intangible cultural heritage resources, and produced series of rural culture documentaries.

(5) Integration of rural and urban areas. Strengthened the supply of basic public services in rural areas, strengthened the construction of rural medical and health systems, staffed rural doctor positions, and enhanced rural medical and health services. Enhanced the integrated development of compulso-

ry education in urban and rural areas, and steadily increased the coverage of high-quality teaching resources in rural areas. Multi-functional and multi-purpose service facility complexes have been built. The social assistance system has been improved to effectively protect the basic livelihood of farmers in difficulty.

(6) Support measures. The construction of rural help team has been strengthened. Innovated rural support model: First, implemented rural collective economic support measures, increased collective income through collective economic support, utilized one hundred idle farm buildings. The special action of helping rural with weak collective economy has been strengthened. Second, increased the support measures for agricultural insurance and agricultural finance, increased the number of insurance varieties and the number of agricultural futures varieties, improved the coverage rate of agricultural insurance, and expanded the amount of equity financing for agriculture-related enterprises.

(7) Supervision and inspection. Implemented the *Regulations on Supervision and Inspection of Chifeng City Rural*, strengthened the assessment and accountability of responsible units and responsible persons around the issue of rural revitalization. Comprehensive analysis, periodic dispatch and departmental coordination mechanisms have been established to carry out periodic inspection and periodic evaluation, which has enhanced the supervision and inspection capacity of the rural.

5.2 Research object

The research object is 12 typical rural of Chifeng City. They are representative because they are national rural revitalization demonstrated rural, national “one rural, one product” demonstrated rural, Chinese beautiful leisure rural, national key rural of tourism, and national forest rural in 2019. They are: Guandongche Rural, Chaidamu Rural, Tongbu Rural, Qiangangtai Rural, Zhazhaiyingzi Rural, Guduhe Rural, Dongnanyingzi Rural, Qianjin Rural, Niujiayingzi Rural, Wanan Rural, Hada Rural, Dongtala Rural.

The rural of Chifeng shows a significant spatio distribution with large dispersion and small agglomeration characteristics (see **Figure 1**). At the macro level, Firstly, the areas in the south of Chifeng are the main agglomeration areas, with high density values and large area distribution characteristics. Secondly, rural is more distributed in the north of the city, forming secondary agglomerations. At the micro level, rural are mostly concentrated in Hongshan District, Songshan District and Ningcheng County.

5.3 Indicator System

Theoretical basis for the construction of the indicator system

(1) Policy theoretical basis

The policy theoretical basis of the study is *The Law of the People's Republic of China on the Promotion of Rural Revitalization*, which was adopted by the Standing Committee of the 13th National People's Congress of the People's Republic of China in 2021. It stipulates that the focus should be on rural industrial development, talent support, cultural prosperity, ecological preservation, organizational construction, urban-rural integration, support measures and supervision and inspection, and the comprehensive implementation of the rural revitalization strategy^[33], which is urgently needed to promote comprehensive upgrading of agriculture, comprehensive progress of rural areas and comprehensive development of farmers, and accelerate the modernization of agriculture and rural areas. At the same time, it actively carries out activities to promote the revitalization of rural industries, talents, culture, ecology and organization, and to promote the development of urban-rural integration.

(2) Economic theoretical basis

The economic theoretical basis of the study is the Cobb-Douglas production function^[34]. It is a production function created by the American mathematician C.W. Cobb and economist Paul H. Douglas when they jointly explored the relationship between inputs and outputs. In this paper, according to the Cobb-Douglas production function, funds, work-



Figure 1. Geographic information and spatio distribution of rural areas in Chifeng City.

force, material resources, and technological progress are considered comprehensively in the construction of the index system.

Indicator Construction

There are some problems in the construction of the previous indicator system. For example, input indicators and output indicators are selected with few regions and small quantities; only hard indicators with quantitative descriptions are considered, and soft indicators with qualitative descriptions are ignored; only desired outputs such as industrial development are considered, and non-desired outputs

such as poor preservation and social assistance are ignored.

In order to solve the real problems in the construction of indicators, this paper, based on the policy and economic theories and combined with the national rural revitalization strategy, constructs a spatio-temporal heterogeneity research indicator system of rural revitalization performance, which contains 13 primary indicators, 20 secondary indicators and 36 tertiary indicators, aiming to measure the rural revitalization performance comprehensive and with multi-perspective, and the finally formed index system (see **Table 1**).

Table 1. Research index system of spatio and temporal heterogeneity of rural revitalization performance.

Indicators	Primary Indicators	Secondary indicators	Tertiary indicators	
Input Indicators	Fund	Agricultural support funds	Financial funds (billion yuan)	
			Social funds (billion yuan)	
			Specialized funds (billion yuan)	
	Workforce	Talent Construction	Number of technical and basic management staff (number)	
			Number of leaders (number)	
	Material resources	Land	Area of agricultural land (thousand hectares)	
			Land utilization rate (%)	
	Industry Development	Industrial Park	Number of modern agricultural parks (number)	
		Industrialization	Participation rate of farmers in industrialized operation (%)	
	Desired Output Indicators	Cultural Prosperity	Cultural Heritage Preservation	Number of agricultural cultural heritage (number)
			Number of intangible cultural heritage (number)	
Cultural Practices			Number of cultural and sports activities (times)	
Ecological Preservation			Number of festival and folklore activities (times)	
		Ecological restoration	Area of wetland restoration (thousand hectares)	
			Area of grassland restoration area (thousand hectares)	
Greening degree			Forest cover (%)	
		Organization construction	Basic organizations	Ruralrs’ satisfaction rate with the openness of rural affairs and democratic management (%)
			Ruralrs’ satisfaction rate with the rural committee (%)	
Economic Organizations	Number of professional cooperative economic organizations (number)			
Non-desired output indicators	Public Education	Medical health care	Proportion of junior high school going on to high school (%)	
			Medical health care	Medical Prevalence Rate (%)
				Number of service institutions and service social organizations (number)
	Urban-rural integration	Social Security	Medical insurance participation rate (%)	
				Endowment insurance participation rate (%)
				Number of insurance varieties (number)
	Support measures	Agricultural Insurance	Coverage rate of agricultural insurance (%)	
				Amount of equity financing for agriculture-related enterprises (billion yuan)
			Agricultural Finance	Number of agricultural product futures varieties (number)
	Supervision and Inspection	Inspection and evaluation	Number of inspection (times)	
Number of periodic evaluate (times)				
Inadequate preservation			Destruction and demolition	Number of natural resources destroyed (number)
				Number of old buildings and ancient dwellings demolished (number)
Ineffective management			Appraisal and Accountability	Number of responsible units and responsible persons punished (number)
Social Assistance	Social assistance workers	Number of rural residents with minimum living standards (10,000 people)		
		Number of rural special hardship people in centralized care (10,000 people)		
		Number of rural special hardship people in scattered care (10,000 people)		

(1) Input indicators. According to the Cobb-Douglas production function, the inputs of the fund, workforce, material and technical progress are considered comprehensively, among which technical progress is a soft indicator, which is more difficult to be assessed quantitatively and cannot be put into the index system, so the GML index can measure the degree of contribution of technical progress to the overall performance. In terms of funds, the funds for supporting agriculture are selected, and the financial funds, social funds and specialized funds can reflect the funds for supporting agriculture; in terms of workforce, the talent construction is selected^[35], and the number of technicians, basic managers and the number of leaders can reflect the talent construction; in terms of material resources, the land is selected, and the number of agricultural land and land utilization rate can reflect the land situation^[36].

(2) Desired output indicators. They are constructed according to several aspects: Industrial development, cultural prosperity, ecological preservation, organization construction, urban-rural integration, support measures, supervision and inspection. In terms of the industry, the industrial parks, industrialized operation are selected, and the number of industrial parks and the participation rate of farmers in industrialized operation can reflect industrial development; in terms of the culture, the cultural heritage preservation and cultural practice are selected, and the number of agricultural cultural heritage and intangible cultural heritage can reflect cultural heritage preservation, the number of cultural and sports activities and festive folklore activities can reflect cultural practice; in terms of the ecology, the ecological restoration and greening degree can be measured, the area of wetland restoration and grassland restoration can reflect the ecological restoration, and the forest coverage rate can reflect the greening degree; in terms of the organization, the basic organizations and economic organizations can be measured, the satisfaction rate of ruralers with the openness and democratic management of rural affairs and the satisfaction rate of ruralers with the rural committee can reflect the basic organizations and the number of

professional cooperative economic organizations can reflect the economic organizations; in terms of the urban-rural integration, the public education, medical and medical health care, and social security can be selected, in terms of urban-rural integration, public education, medical health care and social security are selected. Public education is characterized by the rate of junior high school to senior high school; medical health care is characterized by the prevalence rate of medical care; social security is characterized by the number of service institutions and service social organizations, medical insurance participation rate and endowment insurance participation rate^[37]. In terms of support, agricultural insurance and agricultural finance are selected, the number of insurance varieties and agricultural insurance coverage rate can reflect agricultural insurance; the amount of equity financing for agriculture-related enterprises and the number of agricultural futures varieties can reflect agricultural finance. In terms of supervision, the number of inspections and periodic evaluations can reflect the inspection and evaluation.

(3) Non-desired output indicators. They are constructed from three aspects: ineffective preservation, ineffective management, and social assistance. In terms of ineffective preservation, the number of destruction and demolition of natural resources, the number of demolition of old buildings and ancient dwellings can reflect the destruction and demolition situation; in terms of ineffective management, the number of responsible units and responsible persons punished can reflect the appraisal and accountability; in terms of social assistance, the number of social assistance workers can reflect the social assistance, the number of rural residents with minimum living standards, number of rural special hardship people in centralized and number of rural special hardship people in scattered care can reflect the social assistance^[38].

Indicator Test

The possible redundancy of the tertiary indicators in the rural revitalization performance assessment index system has been tested. The redundancy analysis method based on the combination of qualitative and

quantitative correlation is adopted. After considering the calculation speed and accuracy, the Apriori algorithm is used for qualitative correlation analysis after discretizing the evaluation index values, and then the least squares method and the great uncorrelated method are used for further quantitative correlation analysis, and the results show that there is no obvious correlation among the tertiary indicators. Therefore, the indicator system is not redundant.

5.4 Data collection and processing

(1) Data sources. The data related to the spatio and temporal heterogeneity of rural revitalization performance research index system are obtained from the field research of the subject group from January 2019 to January 2023, interviews with farmers, interviews with relevant departments (Chifeng Rural Social and Economic Survey Team of National Bureau of Statistics, Chifeng Bureau of Statistics, Chifeng Bureau of Agriculture and Animal Husbandry) and relevant internal books. Since the data involve five years of local policies, management, financial audits, participation of multiple interest subjects and other more sensitive information, they are internal information and cannot be made public.

(2) Type of data. The data type is numerical.

(3) Data collection. Three data collection methods are used in the study. 1) Field research method: To conduct a comprehensive investigation of the current situation of rural revitalization in Chifeng City through field visits, field surveys, household interviews and departmental discussions, and to collect a large amount of data information such as relevant photos and videos of the current situation and conduct in-depth analysis. 2) Computer-aided method: Using basic geographic information and related image information as spatio database, based on the GIS platform, we collect and organize geographic information and spatio data, and carry out a series of spatio analysis and processing in order to extract relevant knowledge information, Such as topography, spatio distribution and other digital image information. 3) Internal information access method: local information data collection through internal books,

documents and other materials.

(4) Data processing. Based on the characteristics of the data, for the non-completely missing data, the parabolic interpolation method is used to obtain the specific missing data. For the completely missing data, the average value of the item in other rural in the corresponding year is used as the indicator data of the rural that year.

5.5 Analysis of the results

The spatio-temporal heterogeneity of rural revitalization performance in Chifeng City from 2016 to 2020 is studied using the above-mentioned range-wide EBM-GML model, and the results are obtained by mathematical modeling using Matlab software (see **Table 2**, **Figure 2**, **Figure 3**, **Table 3**, **Figure 4**, and **Figure 5**).

Combined with **Table 2** and **Figure 3**, the overall analysis shows that the overall performance value of rural revitalization in Chifeng is 0.683 from 2016 to 2020, and the performance has increased significantly over the five-year period. Among them, the rate of increase is relatively stable in 2017, and the rate of increase is faster in 2018, 2019, and 2020. The average annual growth rate of performance is 4.46%.

Combined with **Table 2** and **Figure 4**, analyzed by regions, the top four rural of Chifeng city in terms of rural revitalization performance from 2016 to 2020 are Dongnanyingzi rural, Guduhe rural, Qianjin rural, and Wanan rural; the middle four rural are Zhazhaiyingzi rural, Guandongche rural, Dongtala rural, and Niujiayingzi rural; the last four rural are Chaidamu rural, Qiangangtai rural, Tongbu rural, and Hada rural. It can be seen that the performance of rural revitalization in the southern part of Chifeng City is generally better than in other regions.

Analyzed the dynamic trend of spatio and temporal evolution, from 2016 to 2020, the rural revitalization performance of Guduhe and Dongnanyingzi rural increased significantly; Qianjin and Wanan rural fluctuated and increased; Zhazhaiyingzi, Niujiayingzi and Dongtala rural steadily increased; Guandongche, Chaidamu and Tongbu rural are relatively stable; Qiangangtai rural decreased faster and Hada

Table 2. Performance rank of rural revitalization in Chifeng City.

Rural Name	2016	2017	2018	2019	2020	Average Value	Rank
Guandongche	0.748	0.727	0.768	0.768	0.791	0.760	6
Chaidamu	0.485	0.522	0.523	0.563	0.561	0.531	9
Tongbu	0.529	0.442	0.473	0.464	0.518	0.485	11
Qiangangtai	0.588	0.554	0.500	0.474	0.506	0.524	10
Zhazhaiyingzi	0.702	0.696	0.742	0.829	0.874	0.769	5
Guduhe	0.699	0.754	0.896	0.991	1.000	0.868	2
Dongnanyingzi	0.735	0.833	0.865	1.000	1.000	0.887	1
Qianjin	0.781	0.831	0.804	0.917	0.974	0.861	3
Niujiayingzi	0.495	0.516	0.535	0.600	0.626	0.554	8
Wanan	0.791	0.773	0.869	0.840	1.000	0.855	4
Hada	0.428	0.413	0.388	0.411	0.405	0.409	12
Dongtala	0.629	0.646	0.650	0.708	0.814	0.690	7
Average Value	0.634	0.642	0.667	0.713	0.755	0.682	

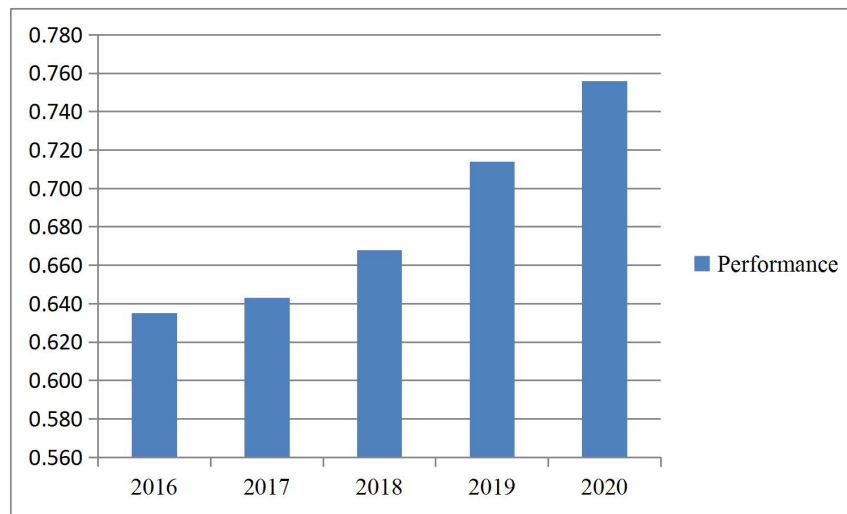


Figure 2. Performance of rural revitalization of Chifeng City by year.

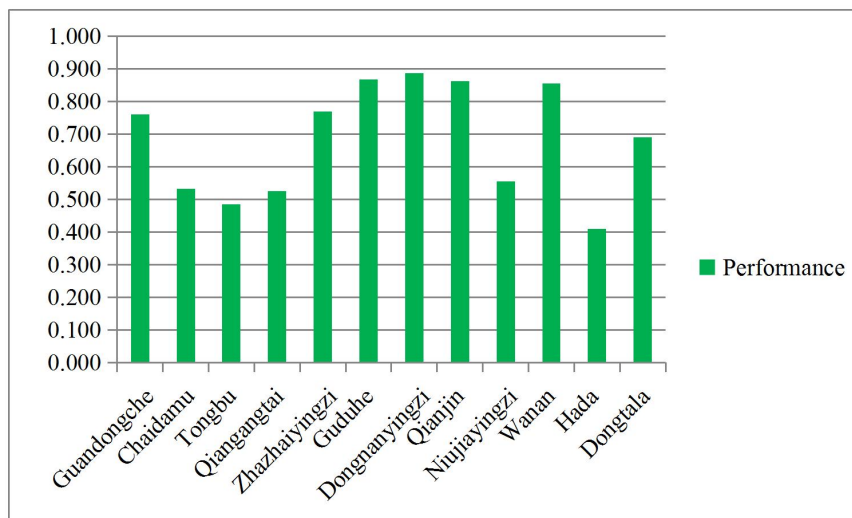


Figure 3. Performance of rural revitalization of Chifeng City by region.

rural decreased slightly.

In terms of performance gap analysis, the highest performance value of 1 in 2016-2020 occurs in Dongnanyingzi rural in 2019, Dongnanyingzi, Wanan and Guduhe rural in 2020. The lowest performance value of 0.389 occurs in Hada rural in 2018. The highest performance occurs in Wanan rural and the lowest performance occurs in Hada rural in 2016; the highest performance occurs in Dongnanyingzi rural and the lowest occurs in Hada rural in 2017; the highest performance occurs in Guduhe rural and the lowest occurs in Hada rural in 2018; the highest performance occurs in Dongnanyingzi rural and the lowest occurs in Hada rural in 2019; the highest performance occurs in Guduhe, Dongnanyingzi and

Wanan rural and the lowest occurs in Hada rural in 2020. It can be seen that the rural with the best performance in the five-year period are concentrated in Dongnanyingzi, Guduhe, and Wanan rural. The performance of Hada rural is consistently poor. Meanwhile, it can be seen that the gap between the highest and lowest performance areas in the same year from 2016 to 2020 shows an increasing trend year by year.

Combined with **Table 3** and **Figure 5**, the overall analysis shows that the GML index of rural revitalization performance in Chifeng is 1.174 in 2016-2020, showing an increasing trend. Among them, the growth rate is faster in 2016-2017, 2017-2018 and 2018-2019, and the growth rate decreases slightly in 2019-2020.

Table 3. GML index of rural revitalization performance of Chifeng City.

Rural Name	2016-2017	2017-2018	2018-2019	2019-2020	2016-2020	Rank
Guduhe	0.972	1.056	1.001	1.030	1.057	9
Tongbu	1.077	1.003	1.077	0.997	1.156	8
Dongtala	0.835	1.071	0.982	1.117	0.978	10
Hada	0.943	0.904	0.949	1.068	0.861	12
Qianjin	0.992	1.067	1.118	1.054	1.244	7
Niujiayingzi	1.080	1.189	1.107	1.010	1.431	1
Guandongche	1.134	1.039	1.157	1.001	1.361	2
Dongnanyingzi	1.065	0.969	1.141	1.063	1.248	6
Qiangangtai	1.043	1.038	1.122	1.044	1.264	4
Wanan	0.978	1.125	0.967	1.191	1.263	5
Zhazhaiyingzi	0.966	0.941	1.060	0.986	0.947	11
Chaidamu	1.026	1.007	1.090	1.151	1.292	3
Average Value	1.009	1.034	1.064	1.059	1.175	

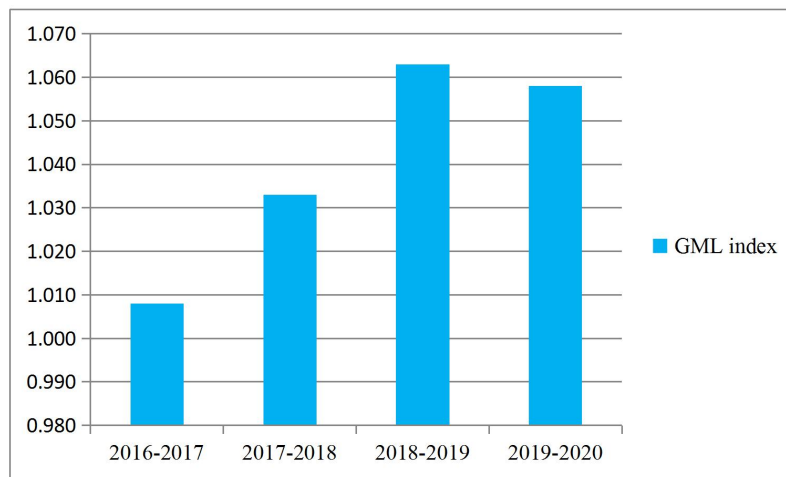


Figure 4. GML index of rural revitalization performance by year of Chifeng City.

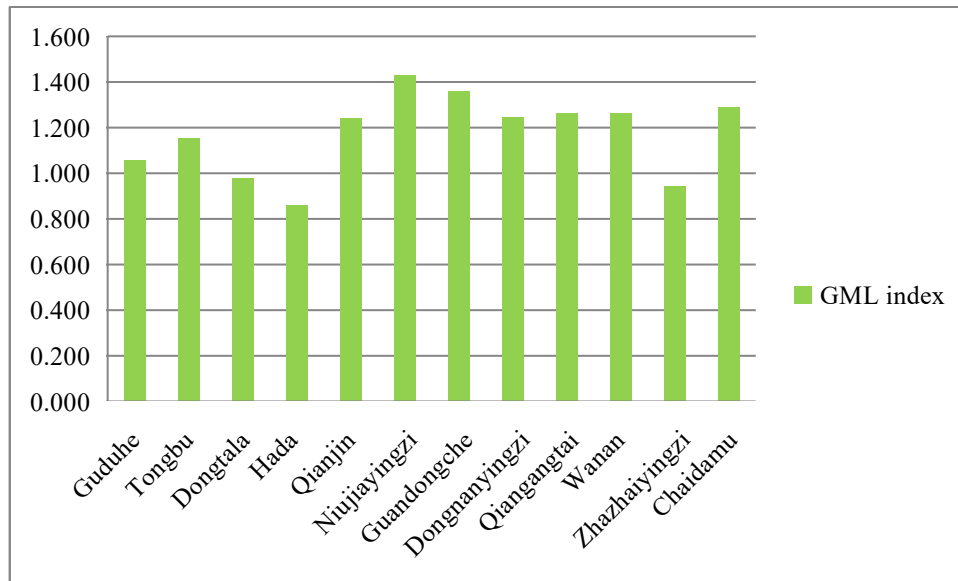


Figure 5. GML index of rural revitalization performance by region of Chifeng City.

Combined with **Table 3** and **Figure 5**, analyzed by region, the top four rural in the Rural Revitalization Performance of Chifeng GML Index from 2016 to 2020 are Niujiayingzi, Guandongche, Chaiyamu, and Qiangangtai Rural; the rural in the middle are Wanan, Dongnanyingzi, Qianjin, and Tongbu Rural; and the last rural are Guduhe, Dongtala, Zhazhaiyingzi, and Hada Rural.

From 2016 to 2020, the rural with rising performance are Guduhe, Tombu, Qianjin, Niujiayingzi, Guandongche, Southeast Yingszi, Qiangangtai, Wanan, and Chaidamu, of which: Qiangangtai and Chaidamu are rising rapidly and Rank in the top 4 overall; the rural with falling performance are Dongtala, Hada, and Zhazhaiyingzi.

From the analysis of spatio-temporal heterogeneity, based on the range of changes in GML index, Chifeng can be divided into three types: Continuous improvement type, fluctuating improvement type, and fluctuating decline type. Niujiayingzi, Guandongche, Qiangangtai, and Chaidamu rural belong to the continuous improvement type; Guduhe, Tongbu, Qianjin, Dongnanyingzi, and Wanan rural belong to the fluctuating improvement type; Dongtala, Hada, and Zhazhaiyinzzi rural belong to the fluctuating decline type.

From the analysis of technological progress, the main contribution to the rising performance of rural

revitalization in the southern of Chifeng City comes from technological progress. Among them, Niujiayingzi, Guandongche, Zhaidamu, and Qiangangtai rural have the highest degree of technological progress, followed by Wanan, Guduhe and Qianjin rural.

6. Conclusions and countermeasure suggestions

By using the range-wide EBM-GML model, the performance of rural revitalization in Chifeng City from 2016 to 2020 is assessed, the implementation of rural revitalization in Chifeng and countermeasures are suggested as follows:

1) The overall performance is improving year by year, while the parts showing high in the southern and northern regions, low in the eastern and western regions.

After analyzing the data of specific indicators and assessment results, it is found that the dynamic assessment performance values of most rural are steadily increasing, no matter the overall rural revitalization by year and by region. This is due to the effective implementation of the national rural revitalization policy of rural in Chifeng.

However, due to the different resource advantages, location advantages, development stages of rural revitalization and degree of spatio gathering of

different rural, the performance of rural revitalization shows a high trend in the southern and northern region, and a low trend in the eastern and western regions. Since the southern region has a better resource advantage, obvious location advantage, and earlier development stage of rural revitalization, as well as being a high-density gathering area (both in terms of the degree of spatio gathering and quantity of spatio gathering, it exceeds other regions), it is generally better than other regions in terms of rural revitalization performance. In order to solve the problem of regional differences, efforts should be made to achieve the linkage development of rural revitalization. On the one hand, the southern and northern regions should continue to consolidate the achievements, update the rural revitalization model, and enhance the radiation and driving effect on the eastern and western regions. On the other hand, the eastern and western regions should learn more from the advanced experience of the southern and northern regions to continuously improve the quality and efficiency of rural revitalization.

2) The extreme difference in assessment increases year by year, showing the Matthew effect.

The analysis of the assessment results shows that the gap between the rural with the highest and lowest assessment values in the same year increases year by year, showing the Matthew effect. This indicates that there is an imbalance in regional performance assessment and a growing gap between assessment values. Therefore, it is necessary to strengthen policy orientation, integrate planning and promotion. On the one hand, strengthen the overall preservation. Integrate the revitalization of rural in Chifeng into the development of rural in eastern Inner Mongolia, so as to make the scope of revitalization broader and deeper. At the same time, reduce non-desired outputs such as destruction and demolition to achieve the goal of strong preservation. On the other hand, strengthen the overall management. At the management level, the management efficiency of rural in Chifeng is improved by reforming the management mode of rural revitalization. At the same time, reduce non-de-

sired outputs such as appraisal and accountability to achieve the goal of effective management.

3) Strengthen technical empowerment and revitalize rural scientifically.

From the assessment results, it is found that the global reference GML index shows an upward trend, indicating that the dynamic assessment performance value is gradually improving. The overall rural revitalization technology progress is significant. Among them: Niujiayingzi, Guandongche, Chaidamu and Qiangangtai rural have made obvious technical progress in rural revitalization. Technology is the premise of efficiency and a powerful tool to improve rural performance. Therefore, in rural revitalization, it is necessary to strengthen technological empowerment, continuously learn advanced technological concepts, and transform technological achievements in time to realize scientific revitalization of rural.

Although this paper has achieved some innovative results, there are inevitably shortcomings and limitations in the research of this paper due to objective factors. For example, the literature is limited, the summary of the existing research is insufficient, and the data collection is inadequate. It needs to be further improved in the future.

Author Contributions

Conceptualization, J.L. (Jiajing Li) and J.L. (Jianing Li); methodology, J.L. (Jiajing Li); software, J.L. (Jianing Li); validation, J.L. (Jianing Li); formal analysis, J.L. (Jiajing Li) and J.L. (Jianing Li); investigation, J.L. (Jiajing Li); resources, P.Z.; data curation, J.L. (Jiajing Li) and J.L. (Jianing Li); writing-original draft preparation, J.L. (Jiajing Li); writing-review and editing, J.L. (Jianing Li); visualization, J.L. (Jiajing Li) and J.L. (Jianing Li); supervision, P.Z.; project administration, P.Z.; funding acquisition, P.Z.

Conflict of Interest

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References

- [1] Xu, Ch., Yang, G. (editors), 2021. *Xiuan cun xing shi jiao xia Jiangsu bu tong xiang cun zhi li mo shi de ji xiao te zheng fenxi* (Chinese) [Analysis of the performance characteristics of different rural governance models in Jiangsu from the perspective of rurality]. 2020/2021 China Urban Planning Annual Conference and 2021 China Urban Planning Academic Season; 2021 Sep 25; Chengdu, Sichuan. p. 1009-1018. DOI: <https://doi.org/10.26914/c.cnkihy.2021.032071>
- [2] Zheng, F.H., Liu, Ch., 2023. *Di fang zheng fu tui jin xiang cun zhen xing ji xiao ping jia: Ti xi yu shi zheng* (Chinese) [Performance assessment of local governments in promoting rural revitalization: System and empirical evidence]. *Journal of South China Agricultural University* (Social Science Edition). 22(01), 86-96.
- [3] Zeng, Zh.Zh., Zhang, J., Zhang, B., et al., 2019. *Xiang cun jian she ping gu zhi biao ti xi yan jiu* (Chinese) [Research on rural construction assessment index system]. *Architect*. 13(05), 78-84.
- [4] Yang, H., 2018. *Guan zhong di qu xin nong cun jian she ji xiao ping gu ji ke chi xu fa zhan mo shi yan jiu* (Chinese) [Research on the performance assessment and sustainable development model of rural revitalization in Guanzhong region] [PhD thesis]. Xi'an: Xi'an University of Architecture and Technology.
- [5] Tang, B., 2017. *Di fang zheng fu sheng tai wen ming jian she ji xiao ping gu de ti xi gou jian yu ji zhi chuang xin yan jiu* (Chinese) [Research on the system construction and mechanism innovation of local government performance assessment of ecological civilization construction] [PhD thesis]. Xiangtan: Xiangtan University.
- [6] De Janvry, A., Sadoulet, E., Murgai, R., 2003. Rural development and rural policy. *Handbook of Agricultural Economics*. 10(2), 1593-1658. DOI: [https://doi.org/10.1016/S1574-0072\(02\)10013-2](https://doi.org/10.1016/S1574-0072(02)10013-2)
- [7] Lynn, M., 2004. The return of community to rural human services? *Rural Society*. 14(3), 228-244. DOI: <https://doi.org/10.5172/rsj.351.14.3.228>
- [8] Tovey, H., 2008. Introduction: Rural sustainable development in the knowledge society. *Sociologia Ruralis*. 10(48), 3-5. DOI: <https://doi.org/10.1111/j.1467-9523.2008.00460.x>
- [9] Borsdorf, A., Hidalgo, R., 2009. Searching for fresh air, tranquillity and rural culture in the mountains: A new lifestyle for Chileans? *Die Erde*. 140(3), 275-292.
- [10] Huang, H., Yang, G.Q., Philip, M., et al., 2017. "Hou xiang cun cheng zhen hua" yu xiang cun zhen xing-dang dai de guo xiang cun gui hua tan suo ji dui zhong guo de q shi (Chinese) ["Post-rural urbanization" and rural revitalization—exploraten of contemporary German rural planning and inspiraten for China]. *Urban Planning*. 41(11), 111-119.
- [11] Zhang, J., 2018. *Xiang cun zhen xing xia xiang cun wen hua yi chan bao hu de "gujiu" yu "weixin"*—jian lun gai ge kai fang 40 nian xiang cun fa zhan zhi du jie du (Chinese) [The "old" and "new" of rural cultural heritage preservation under rural revitalization--and the interpretation of rural development system in the 40 years of reform and opening up]. *Planner*. 34(10), 26-31.
- [12] Luo, Zh.D., Xiang, J.Y., 2019. *Yi dong hu lian wang shi day xin xiang cun fa zhan yu xiang cun zhen xing lu xian* (Chinese) [New rural development and rural revitalization path in the era of mobile internet]. *Urban Planning*. 43(10), 29-36.
- [13] Fan, L.Y., Xu, X., Liu, Y.J., 2019. *Xiang cun zhen xing bei jing xia su nan xiang cun sheng tai ying jian gui hua ce lue* (Chinese) [Ecological camping planning strategy of rural rurals in

- southern Jiangsu in the context of rural revitalization]. *Planner*. 35(11), 24-31.
- [14] Chen, Q.H., Liu, X., Huang, Z.H., et al., 2019. Gong tong di zao: Gao zhi liang xiang cun zhen xing zhi lu (Chinese) [Co-creation: The road to high-quality rural revitalization]. *Urban Planning*. 43(03), 67-74.
- [15] Zhao, Y., Chen, Ch., Xu, Sh.Sh., 2020. Te se tian yuan xiang cun yin ling xia de xian yu xiang cun zhen xing lu jing tan xi-yi Jiangsu sheng Liyang shi wei li (Chinese) [Exploraten of the path of county rural revitalization led by the characteristic idyllic rural—Taking Liyang City, Jiangsu Province as an example]. *Urban Planning*. 44(11), 106-116.
- [16] Kahng Byongkee. [Column] Balanced National Development and Rural Revitalization[J]. *Review of Architecture and Building Science*, 2005, 49(6).
- [17] Irwin, E.G., Isserman, A.M., Kilkenny, M., et al., 2010. A century of research on rural development and regional issues. *American Journal of Agricultural Economics*. 92(2), 522-553.
- [18] Rolínek, L., Cudlínová, E., Klufová, R., et al., 2015. Model strategy for village development in the Czech Republic. *Journal of Central European Agriculture*. 16(1).
DOI: <https://doi.org/10.5513/JCEA01/16.1.1556>
- [19] Zhang, L., 2016. Xiang cun huo hua: Dong ya xiang xun gui hua yu jian she de jing yan yin jian (Chinese) [Rural revitalization: Introductions for rural planning and development in East Asia]. *Urban Planning International*. 31(6), 1-7.
- [20] Zhang, R.L., Yu, J.Zh., Cai, J., et al., 2020. Du shi jin jiao qu xiang cun zhen xing gui hua tan suo—quan yu tu di zong he zheng zhi bei jing xia Tonglu xiang cun zhen xing gui hua shi jian (Chinese) [Exploraten of rural revitalization planning in urban suburban areas—Practice of rural revitalization planning in Tonglu in the context of comprehensive land improvement in the whole area]. *Urban Planning*. 44(S1), 57-66.
- [21] Da, X.J., Zuo, X.T., Ma, L., et al., 2021. Xiang cun zhen xing zhan lue shi shi dao xiang xia de Jiayuguan shi shi yu xiang cun jian she gui hua tan xi (Chinese) [Exploraten of rural construction planning in Jiayuguan city under the guidance of rural revitalization strategy implementation]. *Planner*. 37(18), 65-72.
- [22] Hodge, I., Midmore, P., 2008. Models of rural development and approaches to analysis assessment and decision-making. *Économie rurale*. 3(7), 23-38.
DOI: <https://doi.org/10.4000/economierurale.406>
- [23] Nemes, G., 2005. Integrated rural development—The concept and its operation. New York: IEHAS Discussion Papers.
DOI: <https://doi.org/10.1080/01426398508706149>
- [24] Díez, M.A., Izquierdo, B., Malagón, E., 2016. Increasing the use of evaluation through participation: The experience of a rural sustainable development plan evaluation. *Environmental Policy and Governance*. 26(5), 366-376.
DOI: <https://doi.org/10.1002/eet.1711>
- [25] Ji, Zh.Q., 2018. Xing cun zhen xing zhan lue zhong nong cun ji ceng dang zu zhi ji xiao ping jia ti xi gou jian (Chinese) [Construction of performance assessment system of rural basic party organizations in rural revitalization strategy]. *Party Politics Research*. 10(4), 64-70.
DOI: <https://doi.org/10.13903/j.cnki.cn51-1575/d.2018.04.005>
- [26] Ma, X.J., 2019. Xing cun zhen xing jin cheng Hong wen hua zhi li ji xiao cha ju de shi zheng yan jiu—ji yu quan guo 60 ge cun zhuang de diao cha shu ju (Chinese) [An empirical study on the performance gap of cultural governance in the process of rural revitalization—based on the survey data of 60 rurals nationwide]. *Journal of Henan Normal University (Philosophy and Social Science Edition)*. 46(6), 45-51.
DOI: <https://doi.org/10.16366/j.cnki.1000-2359.2019.06.007>
- [27] Wang, F.J., Lu, J.Zh., 2020. Ji yu ceng ci fen xi fa xia Shanxi sheng xiang zheng fu xiang cun zhen xing ji xiao fen xi-yi Xiaohaotu xiuang wei li (Chinese) [Analysis of rural revitalization performance of Shaanxi provincial township gov-

- ernment based on hierarchical analysis—Taking Xiao Trench rabbit township as an example]. Inner Mongolia Statistics. 6(5), 44-46.
DOI: <https://doi.org/10.19454/j.cnki.cn15-1170/c.2020.05.015>
- [28] Yuan, Ch., Tang, H.Y., 2022. Ji yu xiang cun lv you fa zhan de xiang cun ji xiao yan jiu (Chinese) [Research on the performance of rural revitalization based on rural tourism development]. Business Economics. 7(3), 130-131, 145.
DOI: <https://doi.org/10.19905/j.cnki.syjj1982.2022.03.042>
- [29] Zhang, Q., Li, Sh.Q., 2022. Gong tong fu yu mu biao xia zhong guo xiang cun zhen xing ping jia zhi biao ti xi gou jian (Chinese) [Construction of the evaluation index system of China's rural revitalization under the goal of common prosperity]. Gansu Social Science. (5), 25-34.
DOI: <https://doi.org/10.15891/j.cnki.cn62-1093/c.2022.05.004>
- [30] Yang, X., 2023. Zhongguo xiang cun zhen xing zong he zhi shu ping jia zhi biao ti xi de gou jian yu ying yong (Chinese) [Construction and application of the evaluation index system of comprehensive index for rural revitalization in China]. Regional Economic Review. (1), 54-65.
DOI: <https://doi.org/10.14017/j.cnki.2095-5766.2023.0004>
- [31] Charnes, A., Cooper, W.W., Rhodes, E., 1981. Assessing program and managerial efficiency: An application of data envelopment analysis to program follow through. Management Science. 27(6), 668-697.
- [32] Charnes, A., Cooper, W.W., Rhodes, E., 1981. Evaluating program and managerial efficiency: An application of data envelopment analysis to program follow through. Management Science. 27(6), 607-730.
- [33] Bulletin of the Standing Committee of the National People's Congress of the People's Republic of China, 2021. Zhong hua ren min gong he guo xiang cun zhen xing cu jin fa (Chinese) [Law of the People's Republic of China on Promoting Rural Revitalization] [Internet]. (04), 676-685. Available from: https://kns.cnki.net/kcms2/article/abstract?v=3uoqIhG8C44YLTlOAiTRKibYlV5Vjs7ivZFUTjN1a3juL7iIK-XrzEbmBgjpO-aig8Ggu5tet-xBDM6a_bMOKbhY9qMh6GFS&uniplatform=NZKPT
- [34] Cobb, C.W., Douglas, P.H., 1928. A theory of production. The American Economic Review. 18(1).
- [35] Song, L.T., Bai, Y.X., 2022. Xiang cun zhen xing shui ping ping jia zhi biao ti xi gou jian yu qu yu cha xi fen jie (Chinese) [Construction of the evaluation index system of rural revitalization level and decomposition of regional differences]. Statistics and Decision Making. 38(24), 17-21.
- [36] Wang, Y.H., Yang, Sh.Y., Zhang, Y.L., et al., 2022. Xiang cun zhen xing ji xiao kao he zhi biao ti xi wen xian zong shu (Chinese) [Literature review on performance assessment index system for rural revitalization]. Anhui Agricultural Science. 50(21), 18-21.
- [37] Wu, R.L., 2023. Sheng yu xiang cun zhen xing fa zhan shui ping ce du ji kong jian ji ju te zheng fen xi (Chinese) [Measurement of development level of provincial rural revitalization and analysis of spatio clustering characteristics]. Statistics and Decision Making. 39(04), 59-64.
DOI: <https://doi.org/10.13546/j.cnki.tjy-jc.2023.04.010>
- [38] Li, Ch.L., Li, H.R., Zhou, M.X., 2022. Xiang cun zhen xing ping jia zhi biao ti xi gou jian ji shi zheng (Chinese) [Construction and empirical evidence of rural revitalization evaluation index system]. Statistics and Decision Making. 38(22), 66-70.
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ARTICLE

Changes in Mediterranean Coastline According to the Coastal Type and Land Cover under Climate Change: The Case of South-east Spain

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ABSTRACT

Coastline changes were analyzed considering the land cover types and the analysis of the causes that have determined these changes during the past decades. Through the overlapping of aerial photographs and GIS analysis, the results showed that the land surface increased with respect to the previous stage, gaining terrain to the sea, but this increment was caused by anthropogenic processes. In fact, without human pressure, the land surface beside the coastal line would have decreased, especially on the sandy beaches and coastal dunes. Therefore, the beaches are one of the most vulnerable ecosystems and geomorphological systems due to erosion and lack of sediment supply associated with the modified river courses (i.e. by the construction of reservoirs, concrete channeling, etc.), the inner land use changes, and the effects of global warming on the sea level. Climate change studies predict specific increases in the sea level along the coast. The aim of this work is to know if anthropic activity can reverse the effects of sea level rise and coastal erosion. In fact, it has been done for decades with measures aimed to correct impacts and favour economic activity (i.e. maintaining tourism resources) and not from the environmental issues.

Keywords: Aerial photography; Coastal changes; Coastal erosion; GIS analysis; Sea level

1. Introduction

Coastal ecosystems are a narrow space between the land and sea where living beings are especially

vulnerable due to the scarce extension and the increasing human pressure over time ^[1-4]. The coastal environment is a complex ecosystem and geomor-

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phological system determined by land and sea processes, the weather and the anthropogenic affections, and has regressive and transgressive episodes. Some variations in the coastal area can have serious consequences for the ecosystem and especially in the biotic components^[5]. Several activities alter the environment such as land reclamation from water bodies, filling and desiccation of wetlands and excessive replacement of natural surfaces with impervious materials^[6-8]. Human pressures can affect coastal properties both directly and indirectly. The first one implies the human transformation and adaptation of the coast for its activities (i.e. ports and tourism resources) and the second one means that other human activities can change several characteristics like the chemical properties, the temperature and the turbidity of the water^[4,9], with negative consequences for the ecosystems. Moreover, global warming can intensify coastal erosion due to the sea level rise and waves and coastal wind changes^[4,10-13].

Since the middle of the XX century, the increasing population nearby the coast due to tourism and other activities, has intensified the effects on the coast and the erosion processes on beaches^[12,14-16]. Such is the case of the Mediterranean coast, which is one of the most populated spaces in the world^[14,17,18] and a hotspot of biodiversity^[19]. The tourism development generated a great migration from rural regions to the coast^[20] due to the possibility of finding new jobs. The increment in population leads to a growth in urbanized land and changes in land use and shoreline modifications. Urbanization modifies the original properties of the coast transforming it into altered or urbanized coast with ports, promenades, urban beaches, breakwaters and other infrastructures^[8,10,21]. The smaller surface of the Mediterranean Sea with respect to the oceans, contributes a particular characteristic in terms of marine dynamics.

In general, two main types of coasts constitute the Spanish Mediterranean coastal environment. On the one hand, the rocky coast is close to mountainous ranges (**Figure 1**). On the other hand, sandy coasts in sedimentary basins^[2,4,10,22]. In the first case, the coast is more resistant to erosion and the most com-

mon geomorphological formations in these spaces are cliffs, rocky platforms and gravel coves and beaches^[2,4,22]. The rocks and cliffs are consolidated formations and the gravel coves are more dynamic, but not as much as the sandy beaches, due to the greater granulometry size of the gravel. The emerging part of the coast receives the greatest effects of the waves and coastal storms, whereas the submerged part of the coast erodes more slowly, leaving part of the rock at the same level of the sea, known as rocky platforms (**Figure 1**). In the sedimentary basins, changes in the coast are much more dynamic due to the smaller size of particles forming the beaches, especially in those formed by fine sand. In this case, the wind also acts in the environmental processes, especially by transporting the small grains of sand and dust. The most common formations found in these areas are sandy beaches, dunes and coastal lagoons^[2,23].

The types of coasts regarding geological processes are closely related to seabed geomorphology. In the mountainous coast, the seabed is usually sloping and irregular, whereas, in the sedimentary coasts, the seabed is flatter, with a greater continental shelf formed by fine particle sizes^[23]. In addition, the development of benthonic communities is also important. On the Mediterranean coast, *Posidonia oceanica* plays a key role in fixing the sediments and preventing turbidity of the water. Therefore, *Posidonia oceanica* is important for the quality of the beaches as well as for the marine ecosystem^[2,24]. There are other relevant communities of phanerogams such as *Cymodocea nodosa*, photophilic alga, *Scylaphids algae*, and mixed zones with different species. Sediments, together with the progressive reduction of light because of greater depth, determine the benthic communities in floors or strips parallel to the coast^[23].

The sandy coasts are the result of the accumulation of sediments transported by the river courses and waves-wind action. A change in the amount of the contributions of fine particles will affect the increase or decrease of sedimentary spaces in the coast^[4,12,21,25-27]. Throughout recent history, river basins have undergone various processes that have



Figure 1. Common types of the coast are found in Mediterranean environments.

Source: Authors.

caused significant differences in the sediments that reach the littoral zone. Moreover, a combination of changes in land use far from the coast, i.e. changes in the forest areas, farming systems, urbanization and the creation of infrastructures for water management (reservoirs), have determined an important decrease in the amount of materials input in the coast from rivers. Due to the deficit of inputs and the increment of risk of erosion, coastline regression is noticed ^[27].

Natural and anthropogenic processes act on the coast. The wind is a natural element that causes changes in the emerging part of the coast, especially in the beaches and dune formations. These changes occur on the surface and are diverted by the topography and obstacles encountered. Close to the shoreline, breezes due to the difference in temperature between sea and land are found. During the day the breeze blows from the sea towards the coast while at night, it blows from land to the sea. The most intense winds occur during maritime storms and situations of high atmospheric instability. In addition to the wind, the direction and size of the waves and marine currents also influence the shape of the beaches and

the coastline. In this case, sediment movements occur in the submerged part of the coast and waves and currents affect sandy beaches, gravel, pebbles and even small blocks ^[8,12,21,23].

Seawater temperature is a critical factor for the survival of living organisms, especially in the coastal and sea environment, where temperatures are accentuated due to the narrow sheet of water and close contact with the earth's surface ^[28]. Turbidity occurs more frequently near the coast. Turbidity is a factor that worsens the quality of beaches and decreases the amount of light reaching the seabed. The presence of *Posidonia oceanica* usually fixes sediments to the bottom reducing the turbidity of the beaches ^[2]. On the other hand, the anthropogenic discharges on the coast can produce changes in temperature and addition of nutrients modifying the biota and pollutants ^[29].

There are two types of tides, astronomical tides and meteorological tides. The astronomical tides are produced by the attraction effect generated by the sun and the moon, and meteorological tides are produced by the effect of atmospheric pressure ^[4,8,30]. In the Mediterranean Sea, the meteorological tides alter

the level of the sea a few centimeters above or below, depending on the state of the atmospheric pressure, much more remarkable the effect during the maritime storms, also by the combined effect of the increase of the level of the sea and the height of the waves ^[8]. The stability of the sea level in the Mediterranean Sea is one of the most interesting issues to study climate change impacts in this region.

Human pressure promoted urban expansion, which is one of the main factors that has caused the most important changes on the coast. The urbanized spaces become the inner limit of the beaches, also limiting their space and their growth. What were formerly areas of dunes or diffuse or progressive limits are now maritime promenades and urbanized land ^[2,4,15,31-33]. Ports have increased in number and size for commercial, fishing and recreational water use. The change in land use is another factor related to the urban expansion that has occurred. The increase in population linked to the coast, increases the pressures and impacts on it, but also anthropogenic alterations far from the coast alter the coastal ecosystem (i.e. modifying river systems, the carryover and sediment deposition on the coast). The works that directly modify the coastline may be classified between hard works and soft works. The hard works are represented by the imposition of physical barriers that interrupt and modify the marine dynamics such as ports, urban constructions and breakwaters. The soft works are represented by specific changes that are less durable over time, for instance, the regeneration of beaches by adding sand extracted from the seabed.

Coastal regenerations should be specific modifications that are made to preserve the environment, from the potential risks, with the objective of keeping the ecosystem services, the landscape and sustainable socio-economic activities. Therefore, the nature of the place will be not changed, only the factors that represent a risk should be corrected. A very common case is the recovery of beaches that have been considerably eroded by marine dynamics. But in this case, regeneration will only be considered if the poured materials are equal to the original ones.

But, a gravel beach that is filled with sand is not a regeneration, but a transformation to a new state, mainly for tourism purposes.

However, part of the impacts that occur on the coasts originated in the inland regions. Rivers connect the coast with the inland regions and transport solid materials and dissolved substances in natural conditions. But, under unsustainable management due to serious modifications of the river beds, the transport of sediments is compromised.

In Spain, the coast is a place of great vulnerability as the Spanish legislation recognized (Ley 2/2013) ^[34]. It must be protected against all types of activities and land uses that may be harmful to the coastal and marine ecosystems. In order to avoid that, it is important the delimitation of the Terrestrial Maritime Public Domain (TMPD) and its regulation ^[35]. In addition, other elements that determine the land uses are the land planning strategies through the urban planning of each municipality, and the protected coastal areas, as those included in the European Natura 2000 Network. The current law incorporates into the TMPD the concept of the shore of the sea, which is any space that may be flooded naturally by the effect of tides and waves, including rivers as far as the effects of the sea arrive. This law focuses on the sustainability of the activities that occur on the coast through their concessions and, for the first time, a strategic plan for the adaptation to the effects of climate change was established ^[4].

Considering the effects of climate change on the coast (article 2a), but especially protection and sustainable use are the main demands of the latest Spanish Coastal Law (Ley 2/2013) ^[34]. This is carried out through the Strategy of Adaptation to Climate Change on the Spanish Coast ^[4]. In order to determine the effects that may occur, it is necessary to know the characteristics of each coastal area. From the studies carried out, it has been concluded that the effects of climate change will be different in each coastal space. There are, for example, areas with a high risk of erosion and sea level rise, and others that are more stable and their effects will occur over a longer period of time. In areas with astronomical

tides, the effects of climate change and rising sea levels will occur in a shorter period of time and with greater intensity than in the Mediterranean Sea ^[11]. The effects of climate change are not reduced only to the rise in sea level. In the long term, there may be changes in currents, marine dynamics, winds and tides, accentuating the erosion of beaches and more vulnerable areas ^[11].

This work analyzed the evolution of the southeast coast of Spain, associated with the period when the tourism model and Spanish economy has been developed. This work shows the contrast between the expected reduction of coastal area opposite the increment associated with human pressure. The changes in the shoreline and the surface are directly related to the land use management. Types of the coast and land cover were studied and analyzed in order to determine if changes detected are due to natural processes or anthropogenic actions. Finally, as it is a study of coastal changes over time, attention should be paid to the possible expected effects of climate change, the increment of sea level with a possible reduction of a coastal land surface.

2. Methodology

2.1 Study area

The area selected for this study is located on the Mediterranean southeast coast of Spain. It covers from Cape of Palos (37°37.95'N, 0°41.44'W) to the south and Cape of La Nao (38°44.77'N, 0°13.92'E) to the north and it is represented in **Figure 2**. This area has been selected for its stability, since there is an almost absence of the effects from tides and the sea level in general has few oscillations. In addition, the city of Alicante, which is within the range of the study area, is the reference of the sea level in Spain (marks the point 0 meters above the sea level). The study area is heterogeneous and represents different types of coast and land uses. It is therefore a good example of a Mediterranean coastal environment. This is also one of the most affected areas by the urban expansion and development of tourism for the last 60 years in the Mediterranean basin.

The Spanish Mediterranean coastal climate is generally Csa according to the Köppen-Geiger classification in this area. It is a temperate climate with

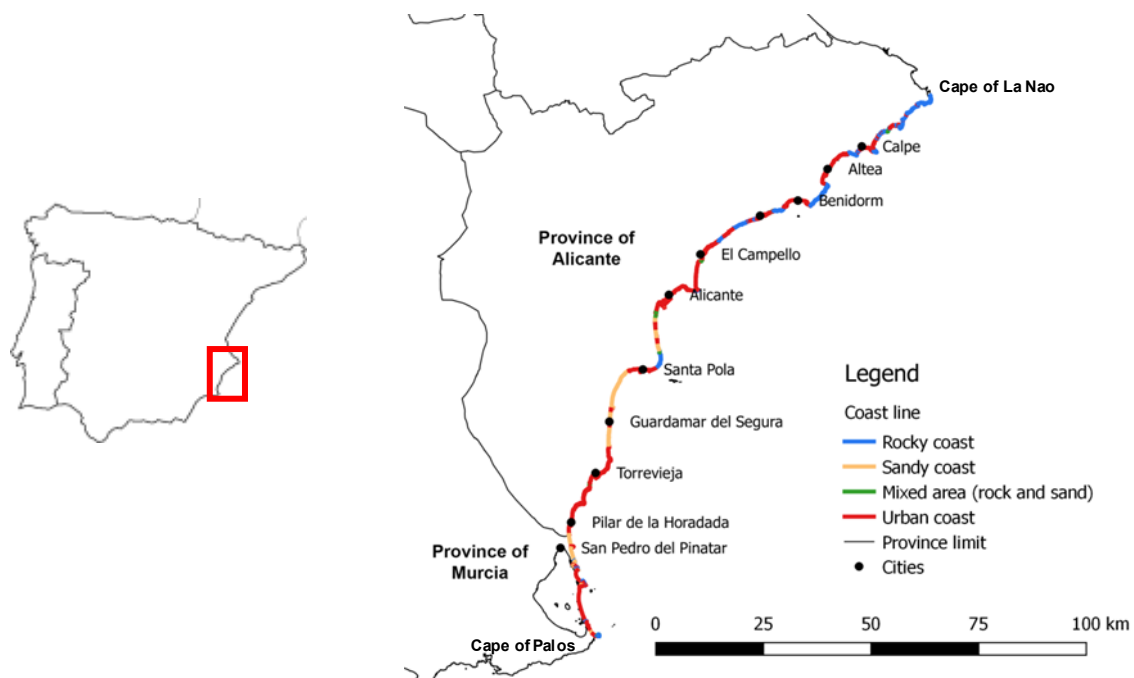


Figure 2. Study area with the different types of coast present in the area.

Source: Own elaboration.

warm summer and winter softened by the effect of the proximity of the sea. The temperatures are mainly equinoctial, being especially arid in the summer months. In the southeast of Iberian Peninsula, the Mediterranean climate has more marked aridity, and in several cases, the climate becomes BSh in the Köppen-Geiger classification, known as mid-latitude steppe and desert climate ^[36].

2.2 Aerial photography

Changes in the coastline can be determined by photo interpretation of aerial images. On the one hand, aerial images from the period 1956-1957 taken in a flight called *American Flight* were used, *American Flight B* series from the IGN (open source: National Geographic Institute, Army Map Service (USA), 1956-1957. [Vuelo americano Serie B] [fotografías aéreas]. 1:33.000. Madrid: Centro Cartográfico y Fotográfico del Ejército del Aire). On the other hand, the recent orthophotos belonging to the years 2014 (province of Alicante) and 2016 (province of Murcia), have been obtained from the PNOA (open source: National Plan of Aerial Orthophotography, PNOA 2014-2016 CC BY 4.0 www.scn.es). Both were used to determine the coastline and to study land cover changes in this research. The methodology employed was similar to the one used in the works of Cremades et al. ^[37] and Pagán ^[8,15,38], since they used aerial photography to establish comparisons of the coastal line. The difference is that those works focused on sandy beaches, while our objective

is to obtain data on changes in all the types of coasts, covers and land use under the expected effects of climate change or anthropic changes.

2.3 GIS analysis

The software QGIS 3.16 (Hannover) was used for processing the aerial images obtained through the WMS server (World Map Service) of PNOA and IGN (National Geographic Institute). The first step was to trace the coastline of both periods (1956-1957 and 2014-2016). Both coastlines were disposed of under the same coordinated system, orthogonally projected and adjusted (resampling) ^[39].

By means of the superposition of both coastlines (overlapping), a series of polygons was obtained marking zones where the coast did not fit in both periods (coastal changes). These zones may be due to the increase or decrease of the coastal surface with respect to the previous situation. In **Figure 3**, an example of coastal changes is given to understand the methodology followed in this work. The data obtained (surface changes) were incorporated into the database together with the type of land cover (land use considering anthropic areas) of each zone.

In this work, knowing the regional environment and historical changes, it is interesting to consider the nature of these changes. In the ports and coastal infrastructures, the changes are always considered artificial (man-made). On the beaches, however, they may have an artificial origin (replenishment, regeneration, etc.) or a natural origin (wind, ma-

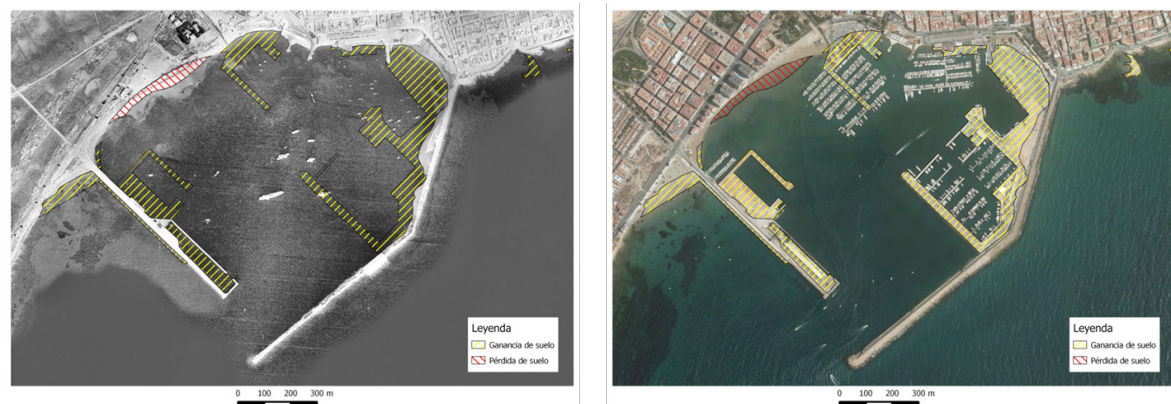


Figure 3. Coastline changes between 1956 (left) and 2014 (right) in Torrevieja (Alicante, Spain). In red colour the loss of coastal area and in yellow is the gain of the coastal area.

rine dynamics, erosion, etc.). In most cases, there is some anthropic influence but only intentional human changes on the coast, due to artificial works, regenerations and other alterations, will be considered artificial processes. Most of the changes produced in these areas will be considered natural changes during this period.

The coast was classified into four categories, according to the characteristics of the coast presented in the study area: The sandy coast, the rocky coast, the mixed rock-sand coast and the urban coast.

The Corine Land Cover classification system was used for land cover types (Copernicus Programme) ^[40], adding a space of special interest for the analysis of changes in sea level, which was the rocky platforms. The rocky platforms are flat spaces that are close to the sea due to the erosive effect of the waves on the cliffs and coastal rocks. The rise in sea level would facilitate the regression in part or totally of the rocky platform space. The land cover classification used to describe the polygons are presented in **Table 1**.

3. Results

3.1 Coastal types

The types of coasts were classified following the four categories established (**Table 1**) and the coastal line length obtained for each one is presented in **Table 2** for both periods analyzed. These results from PNOA 2014-2016 indicate that more than half of the coastline (close to 65%) was urbanized. The 35% would be considered as natural formations although not exempt from several anthropic influences (i.e. disperse occupation, access to beaches, etc.). 23% is a rocky coast and 11% is a sandy or sedimentary coast. In general, a reduction of all the categories except urbanized coastline was detected from 1956-1957 to 2014-2016.

After the superposition of both coastlines, from the middle of the XX century to the recent aerial photography, polygons, where changes occurred (modification of coastal line), were determined and

Table 1. Characteristics used to describe polygonal space units.

Land cover	Process type	Change type	Coast type
Beaches	Artificial	Increase	Rocky coast
Breakwaters	Natural	Decrease	Sandy coast
Cliffs			Mixed rock-sand coast
Port areas			Urban coast
Promenades			
Rocky platform			
Sparsely vegetated areas			
Urban areas			
Water courses			

Table 2. Coastal perimeter related to the types of the coast.

	American flight 1956-1957		PNOA 2014-2016	
Coastal type	Lenght (km)	%	Lenght (km)	%
Rocky coast	164.68	63.01%	67.71	22.8%
Sandy coast	38.26	14.64%	31.33	10.6%
Mixed rock-sand coast	20.41	7.81%	5.86	2%
Urban coast	38.01	14.54%	191.8	64.6%
Total	261.36	100%	296.7	100%

were associated with several natural or human processes.

The results presented in **Table 3**, show the changes (increase or decrease) and the process associated with these changes, classified as artificial or natural changes. In the table, we consider the total increase or decrease due to the sum of artificial and natural changes.

Changes in the surface due to the displacement of the coastline affected all the types of coast considered in this work, increasing or decreasing the area due to the changes in the coastline.

The tendency on the rocky coast was to decrease although its erosion is slow. The sum of the increases and decreases of coastal space is negative, around -15.05 ha in the study area.

The sandy coast represents 10.6% (2014-2016) of the coastline, but it is one of the areas where the majority of changes occur. Decrements dominate increments, especially due to erosion and lack of sediment input from rivers. The changes of artificial origin are not very representative since the classification of sandy coastline refers to dunes and non-urban beaches, where there is no presence of infrastruc-

tures or anthropic modifications. The total change on the sandy coast is negative, with a reduction of the area of -18.86 ha (**Table 3**).

Mixed rock-sand spaces are places with the presence of sand, rocks and materials of varied granulometry, they are transition zones between sandy and rocky coasts. These represent only 2% (2014-2016) of the coastline in the study area. In these spaces, decreases dominate increases and all change processes have been considered as natural processes, with -4.06 ha (**Table 3**).

The urban coast reaches 65% of the coastline in the study area in 2014-2016. It is formed by the coastline of urban fabrics, urban beaches, promenades, ports, docks and any infrastructure that has been built on the coast. In urban coasts, unlike the rest of the typologies, the growth is dominant process. Changes due to artificial processes on the urban coastline have resulted in considerable surface growth, especially represented by the construction and expansion of ports. The global change in the urban coast is an increment of 212.78 ha in the entire study area (**Table 3** and **Figure 4**).

Table 3. Type of changes (artificial and natural) associated to the types of coast (sandy, rocky, mixed rock-sand and urban coast).

Change type	Process	Surface (ha)	Rocky coast (ha)	Sandy coast (ha)	Mixed rock-sand (ha)	Urban coast (ha)
Increase	Artificial	316.41	0	25.31	0.26	290.84
Increase	Natural	29.53	3.10	18.28	1.12	7.03
Decrease	Artificial	-22.34	-0.04	-0.21	-0.01	-22.07
Decrease	Natural	-148.78	-18.12	-62.23	-5.43	-63.01
Total increase		345.94	3.10	43.59	1.38	297.87
Total decrease		-171.12	-18.16	-62.44	-5.44	-85.08
Artificial changes		294.07	-0.04	25.09	0.25	268.77
Natural changes		-119.25	-15.01	-43.95	-4.31	-55.98
Total change		174.82	-15.05	-18.86	-4.06	212.78

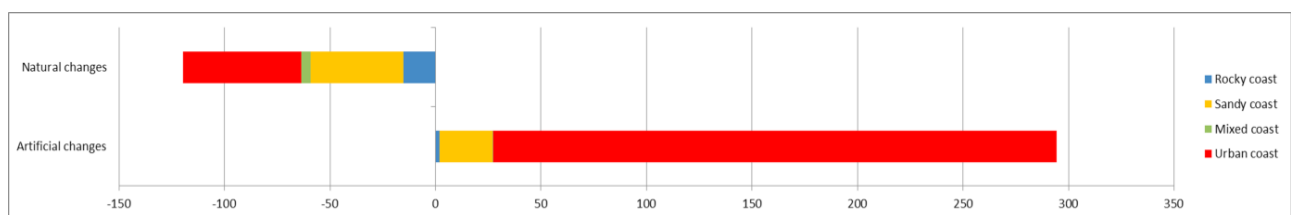


Figure 4. Natural and artificial surface changes in the coast regarding the type of coast.

3.2 Land cover changes

The land cover has been divided into nine categories, eight of from the Corine Land Cover ^[39], and another added by its importance that corresponds to the coastal rocky platform. The rocky platform, being aligned with sea level, would be an indicator of possible changes in sea level. The changes in the different land cover types between the period 1956-1957 and 2014-2016 are shown in **Table 4**.

Beaches are highly dynamic spaces whose materials are eroded and easily transported. On the beaches, erosion dominates over growth despite the anthropic actions carried out for their protection (regeneration, filling, etc.). The total changes in beaches, considering artificial and natural processes, is negative, with -33.93 ha in the study area (**Table 4** and **Figure 5**).

Breakwaters are works carried out on the coast to protect a space or land use from the damage that waves can cause. They are located next to urban beaches, promenades and ports, but they are also used to protect communication routes or urbanized areas. Breakwaters are man-made features and therefore their increase can only be artificial, however in many cases their construction can favor the accumulation and retention of sediments. The total change of the surface of the breakwater cover is an increase of 3.12 ha with respect to the situation in 1956-1957 in the study area (**Table 4** and **Figure 5**).

The cliff changes, in this case, were mainly due to natural processes associated with the erosion resulting

in -6.19 ha (**Table 4** and **Figure 4**). Opposite to this, the ports are the spaces that have provided the greatest increases in coastal space in the study area. Changes are due to artificial processes, both increases and decreases. The increment of the port areas was 197.17 ha in the study area, mainly due to the expansion of the port of Alicante (**Table 4** and **Figure 5**).

The promenades, which are artificial works, apparently maintain the surface, without significative changes as a small reduction is detected (-0.08 ha). However, the effects on rocky platforms have been higher with -10.26 ha (**Table 4** and **Figure 5**). The loss of the rocky platform would be an indicator of sea level rise, however, other effects associated with the geological movements of rising or falling off the coastline could act and it is difficult to determine the origin of the effect in such a short period of time.

On the coastline, some spaces that do not respond to the specific characteristics of others, formed by areas of land with unconsolidated materials that in many cases are the result of discharges of rubble and clearings that were anthropically deposited on the coast and in many cases covered by vegetation were assigned to a cover type defined as sparsely vegetated areas. These spaces tend to grow due to the fact that in most cases their origin is artificial. There was an increase of 30.24 ha in the entire study area (**Table 4**, **Figure 4**).

The urbanized spaces have an increase of 1.94 ha. The watercourses surface losses predominate and in most cases due to artificial processes, with a reduction of -7.19 ha (**Table 4**, **Figure 5**).

Table 4. Type of changes (artificial and natural) associated with land cover in the coastal area.

Change type	Process	Surface (ha)	A	B	C	D	E	F	G	H	I
Increase	Artificial	316.41	69.58	6.92	0.21	200.02	0.46	0.29	36.31	1.94	0.68
Increase	Natural	29.53	23.89	0.05	1.51	0.02	0	0.59	0.87	0	2.60
Decrease	Artificial	-22.34	-9.12	-2.32	0	-2.79	0	-0.16	0	0	-7.95
Decrease	Natural	-148.78	-118.28	-1.52	-7.91	-0.07	-0.55	-10.79	-7.14	0	-2.53
Total increase		345.94	93.47	6.97	1.72	200.04	0.46	0.88	37.18	1.94	3.28
Total decrease		-171.12	-127.40	-3.85	-7.91	-2.86	-0.55	-10.95	-7.14	0.00	-10.47
Artificial changes		294.07	60.46	4.59	0.21	197.23	0.46	0.12	36.31	1.94	-7.27
Natural changes		-119.25	-94.39	-1.48	-6.40	-0.05	-0.55	-10.19	-6.27	0	0.07
Total changes		174.82	-33.93	3.12	-6.19	197.17	-0.08	-10.26	30.24	1.94	-7.19

A: Beaches / B: Breakwaters / C: Cliffs / D: Port areas / E: Promenades / F: Rocky Platform G: Sparsely vegetated areas / H: Urban areas / I: water courses.

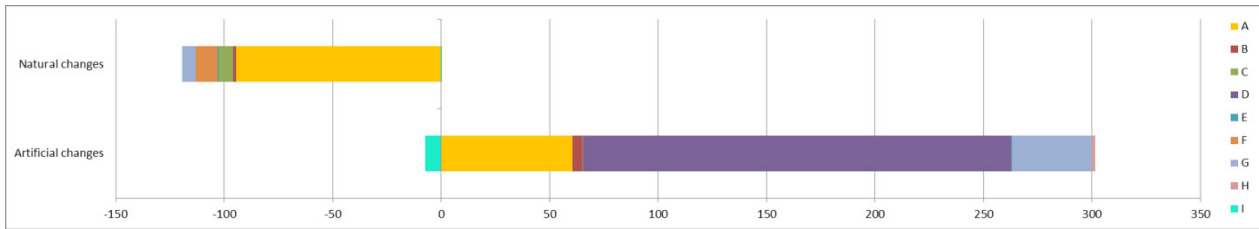


Figure 5. Natural and artificial surface changes in the coast associated with land cover: A-Beaches, B-Breakwaters, C-Cliffs, D-Ports, E-Promenades, F-Rocky Platform, G-Sparsely vegetated areas, H-Urban areas, I-water courses.

Regardless of the type of coastline or land cover, there has been a total increase of the surface estimated at 345.95 ha and the total decrease has been 171.12 ha. Therefore, the balance of land changes in the study area is positive, gaining 174.83 ha. The causes that have produced these changes, increasing the coastal surface, are artificial processes (constructions, regenerations, etc.), while natural processes (winds, waves, currents, sediment deposits, etc.) tend to produce decreases (**Tables 3 and 4**).

Between 1956-1957 and recent years (2014-2016), the coastal surface has grown and it seems a paradox considering the expected effects derived from climate change ^[41], the surface of the coast has maintained and/or increased. A more detailed analysis is necessary to understand what is happening on the coast and the responsibility of artificial human activities in this increment. There is a great difference between the geomorphological factors affecting the coast, and those derived from the high degree of anthropization and urbanization that at least, are the drivers of the processes that have caused a change or displacement of the coastline.

Although it is not the objective of this work, the administration needs to re-think the strategies that should be followed to reduce the expected climate change impact on the coast, considering not only the increment of anthropic works but facilitating the natural processes that can help to maintain the coastline within the rest of actions that should be applied to mitigate climate change.

5. Conclusions

Nowadays, the most natural environments (cliffs, gravel coves and rocky platforms) of the study area

represent only 35.4% of the coast and have suffered changes (−39.19 ha) since the middle of the XX century. The urbanized coast, which represents more than half of the coastline of the study area (64.6%), is a space in which the trend is to increase the area gained to the sea due to anthropization of the coastal area (211 ha). Urban and other anthropic land uses such as ports, promenades and breakwaters, have been increased, which implies the growth of the coastal area and the coastal perimeter). Finally, it is important to notice that the coastal area has increased and especially in previously anthropized areas. In the spaces where the coastline was artificially altered, the coastal area has increased, but, in the areas where natural processes predominate, a progressive loss was noticed.

Beaches are one of the most important land covers because of tourism activities. Beaches can be both natural and urban spaces and there is a great interest in their conservation. However, despite the actions of regeneration and protection of the beaches, the final trend was the loss of surface (−33.93 ha).

The effects of climate change on sea level must be very carefully analyzed, because other geological processes can affect, not only the rising of sea level. Therefore, a slight rise in sea level would be intuited in rocky platforms, although it cannot be confirmed.

The trend over recent years shows an increment in the urbanized coastal area. This behavior is strongly related to the economic activity. Non-urban spaces tend to have a certain regression. In this work, it has been observed how humans are able to adapt and transform the coast, but special attention must be paid to the beaches as they are very fragile and dynamic places with a high environmental, social and economic value.

Author Contributions

Conceptualization (PML, JNP). Methodology (PML). Software (PML). Validation (PML, JNP). Formal analysis (PML, JNP). Investigation (PML). Resources (PML). Data curation (PML). Writing-original draft preparation (PML, JNP). Writing-review and editing (JNP). Visualization (PML, JNP) Supervision (JNP).

Conflicts of Interest

There is no conflict of interest.

Data Availability Statement

Data supporting the research are freely available from IGN (open source: National Geographic Institute) and the PNOA (open source: National Plan of Aerial Orthophotography, PNOA 2014-2016 CC BY 4.0 www.scne.es).

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References

- [1] Such Climent, M.P., 1986. Turismo y medio ambiente en el litoral alicantino (Spanish) [Tourism and environment in the littoral of Alicante] [Internet]. Diputación Provincial de Alicante, Instituto Alicantino de Cultura Juan Gil-Albert: Alicante, Spain. Available from: <https://dialnet.unirioja.es/servlet/libro?codigo=228764>
- [2] WWF, 2002. El litoral mediterráneo: importancia, diagnóstico y conservación (Spanish) [The Mediterranean coast: Importance, diagnosis and conservation] [Internet]. Available from: http://awsassets.wwf.es/downloads/litoral_02.pdf
- [3] Capdepón Frías, M., 2016. Environmental conflicts derived from tourist-residential urban development. A case applied to the Alicante Coastline. Boletín de la Asociación de Geógrafos Españoles. 71, 463-466.
- [4] MAPAMA, 2016. Estrategia de Adaptación al Cambio Climático de la Costa Española (Spanish) [Climate change adaptation strategy of the Spanish coast] [Internet]. Available from: https://www.miteco.gob.es/es/costas/temas/proteccion-costa/estrategiaadaptacionccaprobada_tcm30-420088.pdf
- [5] Bakker, J.P., Baas, A.C., Bartholdy, J., et al., 2016. Environmental impacts—coastal ecosystems. North Sea region climate change assessment. Springer International Publishing: Cham. pp. 275-314. DOI: https://doi.org/10.1007/978-3-319-39745-0_9
- [6] Jongman, B., Ward, P.J., Aerts, J.C., 2012. Global exposure to river and coastal flooding: Long term trends and changes. Global Environmental Change. 22(4), 823-835. DOI: <https://doi.org/10.1016/j.gloenvcha.2012.07.004>
- [7] Craft, C., Clough, J., Joye, S., et al., 2009. Forecasting the effects of accelerated sea-level rise on tidal marsh ecosystem services. Frontiers in Ecology and the Environment. 7(2), 73-78.
- [8] Pagán, J.I., López, I., Aragonés, L., et al., 2017. The effects of the anthropic actions on the sandy beaches of Guardamar del Segura, Spain. Science of The Total Environment. 601, 1364-1377.
- [9] Giovanni Cannizzaro, M.V., 2002. La teledetección y otras técnicas avanzadas como instrumentos de apoyo para la protección de las áreas marinas y costeras del Mediterráneo (Spanish) [Remote sensing and other advanced techniques as support tools for the protection of Mediterranean marine and coastal areas]. Instrumentos Jurídicos y de Gestión para la Conservación del Litoral Mediterráneo, Palma de Mallorca, Spain, 6-8 junio de 2002, MAP-UNEP: pp. 184-192. Available from: <https://stg-wedocs.unep.org/bitstream/handle/20.500.11822/1923/legalsem02s-pa.pdf?sequence=2&isAllowed=y#page=184>
- [10] Wong, P.P., Losada, I.J., Gattuso, J.P., et al., 2014. Coastal systems and low-lying areas. Climate change 2014: Impacts, adaptation, and vul-

- nerability. Part A: Global and sectoral aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press: Cambridge. pp. 361-409.
- [11] Losada, I., Izaguirre, C., Diaz, P., 2014. Cambio climático en la costa española (Spanish) [Climate change on the Spanish coast]. Oficina Española de Cambio Climático, Ministerio de Agricultura, Alimentación y Medio Ambiente. Madrid, Spain. pp. 133. Available from: https://www.miteco.gob.es/es/cambio-climatico/publicaciones/publicaciones/2014%20INFORME%20C3E%20final_tcm30-178459.pdf
- [12] De la Peña Olivas, J.M., Antón Camacho, A.I., Lechuga Álvaro, A., et al., 2015. Estrategia de Actuación en la Costa Sur de Valencia (Puerto de Valencia -Puerto de Denia) (Spanish) [Action Strategy on the South Coast of Valencia (Port of Valencia-Port of Denia)] [Internet]. Ministerio de Agricultura, Alimentación y Medio Ambiente. Secretaría de Estado de Medio Ambiente. Dirección General de Sostenibilidad de la Costa y del Mar. CEDEX (Centro de Estudios y Experimentación de Obras Públicas), Madrid, Spain. Available from: https://www.miteco.gob.es/es/costas/temas/proteccion-costa/estrategiaactuacionvalenciafinalmemoriared1b_tcm30-163219.pdf
- [13] Arnell, N.W., Lloyd-Hughes, B., 2014. The global-scale impacts of Climate Change on water resources and flooding under new climate and socio-economic scenarios. *Climatic Change*. 122, 127-140.
- [14] Cori, B., 1999. Spatial dynamics of Mediterranean coastal regions. *Journal of Coastal Conservation*. 5, 105-112.
- [15] Pagán, J.I., Aragonés, L., López, I., et al., 2017. La evolución de la línea de costa en las playas de arena del Levante mediterráneo (Spanish) [The evolution of the coastline on the sandy beaches of the Levante Mediterranean]. XIV Jornadas Españolas de Ingeniería de Costas y Puertos, Alicante, Spain, 24 y 25 de mayo de 2017.
- [16] Scott, D., Gössling, S., Hall, C.M., 2012. International tourism and climate change. *Wiley Interdisciplinary Reviews: Climate Change*. 3(3), 213-232.
- [17] Creel, L., 2003. Ripple effects: Population and coastal regions. Population Reference Bureau: Washington, DC. pp. 1-7.
- [18] Setioko, B., 2010. The metamorphosis of a coastal city (case study Semarang Metropolitan). *Journal of Coastal Development*. 13(3), 148-159.
- [19] Cuttelod, A., García, N., Abdul Malak, D., et al., 2008. The Mediterranean: A biodiversity hotspot under threat. The 2008 Review of the IUCN Red List of Threatened Species. IUCN: Gland, Switzerland.
- [20] Losada, M.A., 2021. Las riberas del mar océano (Spanish) [The shores of the ocean sea] [Internet] [cited 2021 Sep 22]. Available from: <https://ingenieriaenlared.wordpress.com/2010/09/29/%C2%AB-las-riberas-del-mar-oceano%C2%BB-capitulo-113-el-documental-que-pretendia-censurar-el-ministerio-de-medio-ambiente-con-guion-de-miguel-angel-losada/>
- [21] Aragonés, L., Pagán, J.I., López, M.P., et al., 2017. The impacts of Segura River (Spain) Channelization on the coastal seabed. *Science of the Total Environment*. 543, 493-504.
- [22] Aranda, M., García, F.J., Pérez-Alberti, A., 2017. Combining geomorphological and ecological criteria for the classification of the Spanish coastal habitat types. IX Jornadas de Geomorfología Litoral. Menorca, Spain. *Geo-Temas*, pp. 1576-5172.
- [23] Guillén, J., Hoekstra, P., 1996. The “equilibrium” distribution of grain size fractions and its implications for cross-shore sediment transport: A conceptual model. *Marine Geology*. 135(1-4), 15-33.
- [24] Jordà, G., Marbà, N., Duarte, C.M., 2012. Mediterranean seagrass vulnerable to regional climate warming. *Nature Climate Change*. 2(11), 821-824.

- [25] García-Mora, M., Gallego-Fernández, J., Williams, A., et al., 2001 A coastal dune vulnerability classification. A case study of the SW Iberian Peninsula. *Journal of Coastal Research*. 17(4), 802-811.
- [26] Syvitski, J.P.M., Vörösmarty, C.J., Kettner, A.J., et al., 2005. Impact of humans on the flux of terrestrial sediment to the global coastal ocean. *Science*. 308(5720), 376-380.
- [27] Tent-Manclús, J.E., 2013. Cambio de la línea de costa en el Bajo Segura (Sur de Alicante) en los últimos 15.000 años (Spanish) [Coast line change in the Bajo Segura (South of Alicante) in the last 15,000 years]. *Estudios Geográficos*. LXXIV(275), 683-702.
DOI: <https://doi.org/10.3989/estgeogr.201324>
- [28] Lima, F.P., Wethey, D.S., 2012. Three decades of high-resolution coastal sea surface temperatures reveal more than warming. *Nature Communications*. 3(1), 1-13.
- [29] Robledo Ardila, P.A., Álvarez Alonso, R., Durán Valsero, J.J., et al., 2023. Assessment of heavy metal pollution in marine sediments from south-west of Mallorca island, Spain. *Environmental Science and Pollution Research*. 30, 16852-16866.
- [30] Grobas Frigole, M., Espino Infantes, M., Martínez Benjamín, J.J., 2003. Variaciones del nivel del mar en el Mediterráneo occidental a partir de los datos suministrados por los mareógrafos (Spanish) [Sea level variations in the western Mediterranean based on data supplied by tide gauges] [Internet]. UPCommons. Portal de acceso abierto al conocimiento de la UPC. Available from: <http://hdl.handle.net/2099.1/5996>
- [31] Delgado, A., Equipo, O.S.E., 2011. Sostenibilidad en España 2011 (Spanish) [Sustainability in Spain 2011] [Internet]. Mundiprensa: Spain. Available from: https://www.researchgate.net/publication/301302488_Sostenibilidad_en_Espana_2011
- [32] Martí Ciriquíán, P., Nolasco-Cirugeda, A., 2011. Urbanismo expansivo: de la utopía a la realidad (Spanish) [Expansive urbanism: From utopia to reality]. XXII Congreso de Geógrafos Españoles, Universidad de Alicante, Spain. Asociación de Geógrafos Españoles. pp. 367-378. Available from: <http://hdl.handle.net/10045/48395>
- [33] Romano Grullón, Y., Roca Cladera, J., 2011. El análisis del continuo urbano en la costa mediterránea Española (Spanish) [The analysis of the urban continuum on the Spanish Mediterranean coast]. Universitat Politècnica de Catalunya. Centre de Política de Sòl i Valoracions. Available from: https://upcommons.upc.edu/bitstream/handle/2117/15453/01_2011.pdf
- [34] Ley 2/2013, de 29 de mayo, de protección y uso sostenible del litoral y de modificación de la Ley 22/1988, de 28 de julio, de Costas (Spanish) [Law 2/2013, of May 29, on the protection and sustainable use of the coast and modification of Law 22/1988, of July 28, on Coasts]. BOE Núm. 129, jueves 30 de mayo de 2013. Sec. I. P. 40691.
- [35] Torres, F., 2010. Cuarenta años de leyes de costas en España (1969-2009) (Spanish) [Forty years of coastal laws in Spain (1969-2009)]. *Investigaciones Geográficas* 52, Instituto Interuniversitario de Geografía, Universidad de Alicante. pp. 167-198.
- [36] Arnfield, A.J., Rafferty, J.P., Augustyn, A., et al., 2018. Köppen Climate Classification [Internet]. *Encyclopaedia Britannica*. Available from: <https://www.britannica.com/science/Koppen-climate-classification>
- [37] Cremades, D., Navarro-Pedreño, J., Gómez, I., et al., 2005. Situación del litoral de los municipios de Elche y Santa Pola (Spanish) [Situation of the coastline of the municipalities of Elche and Santa Pola]. *Políticas urbanas y territoriales en la Península Ibérica*, Junta de Extremadura, Mérida, Spain. 1, 121-136.
- [38] Pagán, J.I., López, I., Tenza-Abril, A.J., et al., 2018. Urban growth and beach nourishment: Experiences in the coast of Alicante, Spain. *WIT Transactions on the Built Environment*. 179, 93-

- 102.
- [39] Nelson, T., Wulder, M., Niemann, K., 2001. Spatial resolution implications of digitizing aerial photography for environmental applications. *Imaging Science Journal*. 49(4), 223-232.
- [40] Corine Land Cover [Internet] [cited 2021 Sep 25]. Available from: <https://land.copernicus.eu/pan-european/corine-land-cover>
- [41] Climate Change and Land [Internet]. IPCC; 2020 [cited 2021 Mar 29]. Available from: https://www.ipcc.ch/site/assets/uploads/sites/4/2020/02/SPM_Updated-Jan20.pdf

ARTICLE

Perception of the Residential Environmental Quality of Yenagoa Metropolis, Nigeria

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ABSTRACT

Residential environmental quality (REQ) affects human health and quality of life (QoL). Therefore, this study assessed residents' perception of the REQ of the Yenagoa metropolis. Data for the study were sourced from the 400 administered questionnaires, which required respondents to rate their REQ based on seven selected indicators (air quality, drinking water quality, housing location, sanitation, waste management, housing accessibility and noise pollution). The respondents were sampled using the multistage sampling technique. The data were analyzed using frequency, percentage, t-test, ANOVA and REQ model. The findings show that the overall calculated REQ of Yenagoa was classified as "good quality". The best-rated indicator was drinking water quality, while the least-rated was noise pollution. Ratings based on respondents' sex, income and educational status recorded similar results. Also, the respondents' perception of the REQ across the four zones was similar as the calculated ratings of all the zones fell under the "good quality" classification. Furthermore, the hypotheses tested revealed that there were no significant differences in the perception of the REQ by sex and income status, while significant variation exists by education status. Despite the general "good quality" rating, there is still room for improvement, especially in the areas of noise pollution, sanitation and housing location, which received relatively low ratings.

Keywords: Air quality; Drinking water quality; Noise pollution; Residential environmental quality; Waste management

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1. Introduction

The rate of population growth and urbanization has been increasing in recent decades. It has been projected that by 2050, the world's urban population would be 68%, as against the 55% in 2018 ^[1]. This accounts for a 13% increase for a period of 32 years. The report also asserts that 35% of this growth will take place primarily in Nigeria, China and India. These countries are expected to add 189, 255 and 416 million people to their respective urban populations by 2050. Unfortunately, the higher the population of an urban area, the higher the density, which in turn exerts stress on the environment, leading to urban deterioration with negative effects on the population. The most common effects include air, water and noise pollution, waste management challenges, building in flood-prone and poorly accessible areas amongst others.

The linkage between residential environmental quality (REQ) and human health, quality of life (QoL) and standard of living has been established by several studies ^[2-6]. This is so because, human health and well-being are influenced by some of the environmental quality indicators such as clean air, safe drinking water, adequate sanitation and proper waste management. Hence, the incorporation of residents' perceptions would lead to a better understanding of environmental pollution problems and enhance local planning for the sustainability of the urban area ^[7].

Studies on REQ are usually carried out based on some selected indicators, which are used to assess the prevailing environmental quality of the area of interest. Assessment of REQ may involve an array of indicators, ranging from air, water, residential location, town planning to social services. Hence, environmental quality studies are usually considered as multidimensional constructs, which are conducted using either objective or subjective approaches ^[8]. The objective environmental quality assessment is usually based on the adoption of technical measurement systems, which can give precise quality values of the indicator being measured based on the design of the measuring instrument and its calibration. This method is considered objective because it is not in-

fluenced by the bias and prejudices of the assessor. On the other hand, the subjective method is based on people's perception of their REQ, based on selected environmental quality indicators, using some kind of Likert scale, which may range from "very good to very poor", with assigned weight values based on their perceived importance in contributing to the assessment of the overall quality of the environment. This study adopted the subjective method in the assessment of the REQ of Yenagoa metropolis because the residents can relate their perceived REQ with their residential satisfaction, perceived health status and QoL.

The resident's rating of environmental quality drivers or indicators can constitute reliable information in gauging the capacity of the environment to support human health and wellbeing. They can also help in providing early warning signs of impending environmental stress and shocks, which can enhance the abilities of environmental practitioners, regulators and policymakers to respond proactively to impending environmental threats. Hence, the continuous evaluation and monitoring of the major residential quality drivers could help to facilitate achieving sustainable residential environmental quality by the timely implementation of appropriate measures to forestall any impending environmental problem ^[9]. In a similar vein, a study asserts that "environmental health indices that can capture the multiple dimensions of healthy housing are important tools for characterizing the risk of exposure as well as evaluating the effectiveness of interventions" ^[10].

In spite of the linkages between REQ and residents' perceived health and QoL, there is a dearth of reliable information and baseline data on residents' PREQ of most cities in Nigeria, especially Yenagoa. This situation has made it difficult to proactively deal with impending environmental threats and shocks that the residents are exposed to. Therefore, it is imperative to conduct studies to continuously monitor and appraise the quality of the residential environment to ensure that the capacity of the environment is not overstretched but capable of sustainably maintaining the health of the residents. Hence, the aim

of this study is to assess the residents' perception of REQ of the Yenagoa metropolis.

2. Literature review

Studies have established that the quality of the residential environment largely influences human health, QoL and mental well-being^[6,11,12]. Hence, a higher perceived REQ is linked with better well-being^[11] and a poorly perceived REQ is linked with poor well-being^[13].

For this reason, it is imperative to continuously monitor the residential environment to ensure that its quality does not deteriorate to levels that would pose serious threats to human life and well-being. The measurement or monitoring of the environment can be done either through objective or subjective means. However, there have been increases in the number of studies that have adopted the subjective approach, which is based on the perception of residents on their REQ^[12,14,15]. One of the reasons for opting for subjective approach is that residents' perception of REQ could provide dependable stock of information that could guide policymakers, environmental regulators and other relevant stakeholders on the development of policies and environmental regulations, which could directly address the concerns of the people thereby enhancing good government and people relations, which may lead to less resistance to government policies and environmental regulations. Secondly, since the residents are the ones directly affected by the quality of the residential environment, and policies to improve the REQ are designed for the benefit of the same residents, it is only logical and imperative that the residents' perception of the environmental quality be sought before embarking on any improvement strategies.

A review of the literature has shown that different proxy indicators have been adopted in studies of REQ with different outcomes. For example, Bonaiuto et al.^[16] adopted 11 proxy indicators as follows: Three focused on spatial aspects, one on human aspects, four on functional aspects and three on contextual aspects. The findings confirm the factorial structure of the indicators and show an improved ex-

tent of reliability in relation to past studies. A study on the "perception of the residential environment in cities: A comparative study" by Hanák et al.^[9] adopted 22 proxy residential environmental indicators to compare three cities-Brno, Prague and Ostrava. The findings indicated that generally the indicators affecting the quality of life in the three cities were similar and they considered safety and noise as major quality indicators impacting their QoL. Another study adopted the "facility adequacy index (FAI), environmental risk factor index (ERFI) and safety perception index (SPI)". The study concluded that the environmental quality of the assessed area was very high, with housing quality showing the highest rating, while water supply was the least rated indicator^[14].

The use of different proxy environmental quality indicators discussed above clearly shows that researchers have not come to a general consensus on the acceptable indicators for studying REQ. The reason for the adoption of diversity of indicators is not farfetched, as the residential environment can be defined and conceived from different perspectives because the concept seems to be relatively vague and loose^[17]. In addition, the scale of the studies also varies; with some focusing on macro levels (a city) while others on the micro level (a neighbourhood in a city or town). It should be stressed at this point that irrespective of the used REQ indicators, its major purpose is to assess the current state of the environment to support ecological and human health and well-being. Having this information, regulators and policymakers could be well armed with impending environmental challenges and better prepared to resolve and manage them more efficiently. Since no generally agreed indicators have been developed for the study of REQ, this study proposed and used seven proxy indicators to assess the REQ of Yenagoa.

3. Methodology

3.1 Description of the study area

The study was carried out in Yenagoa, the capital of Bayelsa State, Nigeria. It is situated "within

latitudes 4°55' and 5°02' North of the Equator and longitudes 6°15' and 6°25' East of the Greenwich Meridian" (see **Figure 1**)^[18]. Yenagoa is located in southern Nigeria, specifically in the Niger Delta, which is characterized by flood plains, tidal flats and beach ridge barriers. The entire area is low-lying and hardly rises above 15 metres. The climatic type

of the area is "tropical monsoon climate, with two distinct seasons-rainy and dry"^[19]. The rainy season is usually experienced from the month of April to October, while the dry season occurs from November to March. The mean monthly temperature ranges between 27-28 °C, with an annual mean rainfall ranging between 2500 mm to 4000 mm and relative

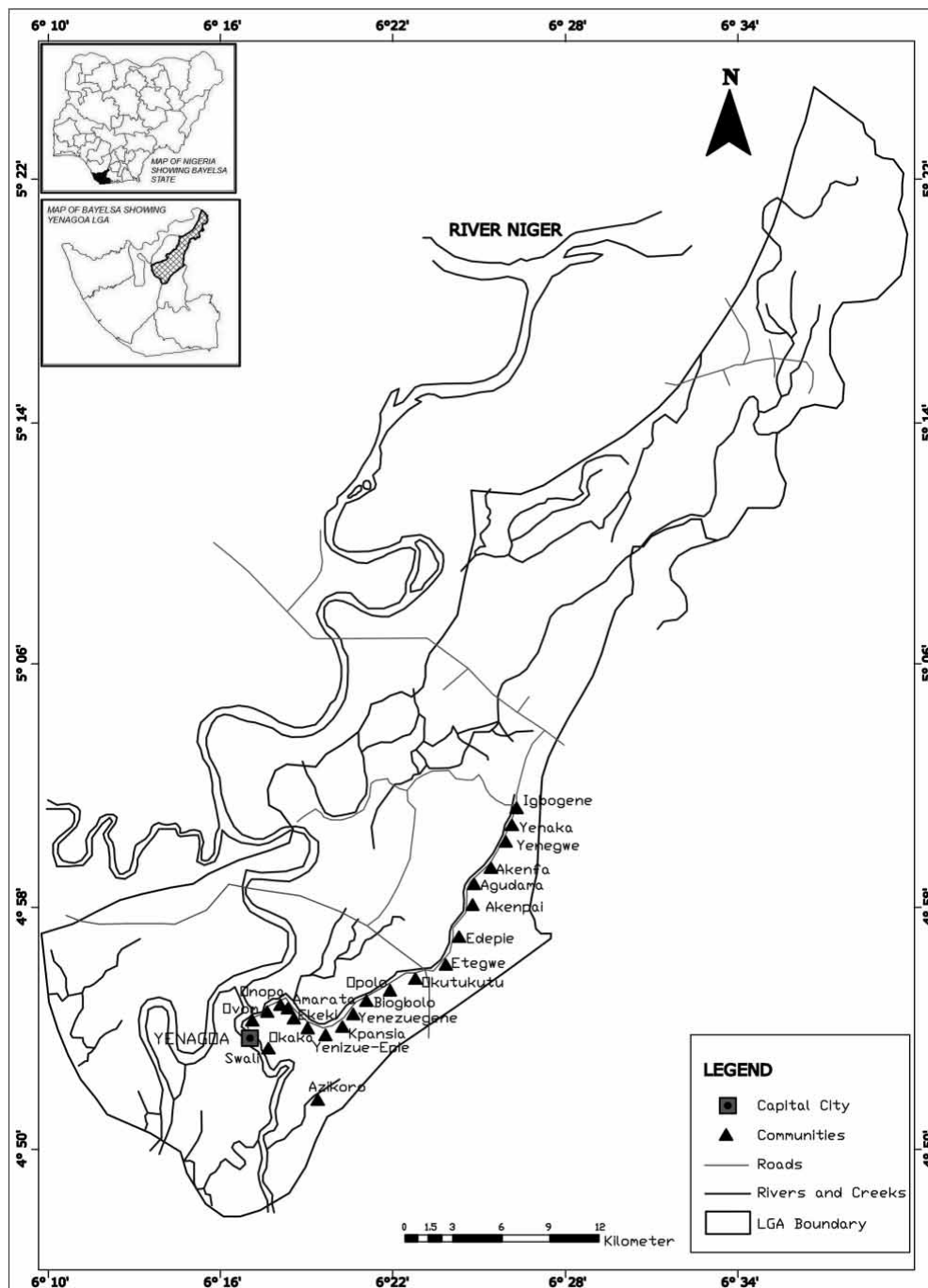


Figure 1. The study area in Yenagoa local government area.

Source: ^[18].

humidity of about 70% ^[19].

Yenagoa has been experiencing a rapid rate of population growth since it was named the capital of Bayelsa State in 1996. The population of the city has progressively grown “from about 50,000 people in 1991 to about 300,000 in 2006” ^[20]. Unfortunately, the growth in population is not commensurate with infrastructural provisions ^[20]. This has created developmental gaps with adverse effects on the livability index of the city and QoL of the people. The developmental gaps manifest in various ways—insufficient decent housing accommodations, road networks, waste management challenges, insufficient safe drinking water, air and noise pollution and poor urban development control. These challenges have adverse effects on productivity and human health. Hence, this study was carried out to assess the residents’ perception of their REQ, which could provide baseline data for future environmental planning and management of the Yenagoa metropolis.

3.2 Methods of data collection

The cross sectional survey research design was used for this study, which involved physical field observation of residential environmental settings and direct field administration of a structured questionnaire. Data for the study were obtained from the administered questionnaire. The questionnaire comprises two parts—A and B. Part A, focused on the respondents’ demographic characteristics, while part B focused on the respondents’ perception of their environmental quality through responses to seven selected REQ indicators or drivers (air quality, drinking water quality, housing location, sanitation, waste management, housing accessibility and noise pollution). Each of the seven indicators had five options, which were rated on a Likert scale format and were assigned quality weight values based on their assumed contributions to REQ. The scale adopted was very good quality—5 points; good quality—4 points; moderate quality—3 points; poor quality—2 points and very poor quality—1 point.

The population for the study was 125,000 households, based on an average household size of four

persons per household ^[19]. In order to obtain a representative sample, the table for estimating sample size from a given population was used to obtain a sample size of 400 ^[21]. To ensure that the 400 samples were a true representation of the population, the multistage sampling technique was adopted. Firstly, Yenagoa was classified into four zones based on the 20 communities that make up the metropolis. Each of the zones comprises five communities, which were assigned alphabets (A-D). The communities in each of the zones were as follows: Zone A (Igbogene, Yenegwe, Akenfa, Agudama & Akenpai); Zone B (Edepie, Etegwe, Okutukutu, Opolo & Biogbolo); Zone C (Yenezuegene, Kpansia, Yenizue-Epie, Ekeki & Amarata); Zone D (Onopa, Ovom, Okaka, Swali & Azikoro). The respondents were later sampled using the systematic random sampling technique at every six housing intervals. The designed questionnaire was then administered to the sampled respondents directly by hand to fill and return.

3.3 Methods of data analysis

The responses from the administered questionnaire constituted the data for the study, which were analyzed using percentages, frequencies, t-test, analysis of variance (ANOVA) and a REQ arithmetical model that was adapted from the waterborne diseases vulnerability (WDV) model by ^[11]. Frequencies and percentages were used to analyze the data on respondents’ demographic characteristics and responses to the REQ indicators; while the REQ model was used to assess the perceptual rating of the REQ indicators by the respondents. The model integrates the various responses of the respondents to the seven selected REQ indicators to arrive at a single value, which shows the REQ rating of the metropolis. Apart from the general rating by all respondents, a cross tabulation rating was also carried out to determine the ratings based on sex, education, income status and residential zones. The t-test statistic was used to determine whether there was a significant difference between male and female perception of the REQ indicators; while the ANOVA was used to determine whether there was a significant variation in the rating

of REQ indicators by education and income status. The REQ model is stated as follows:

$$REQ = \frac{req_i}{hq} \times \frac{100}{1} \quad (1)$$

where:

$$req_i = \sum_{f=1}^n \frac{q(f)}{TR}; i = 1, 2, 3, 4, 5 \quad (2)$$

REQ = residential environmental quality; req_i = residential environmental quality index; q = quality unit weight, a number between 1-5; hq = highest quality unit weight, 5; f = number of responses to a quality unit weight (1-5) of each ith indicator, a number between 1-7; TR = total number of responses to all quality unit weight values (1-5) of all ith indicators (1-7) and \sum = summation.

The calculated rating of the REQ is presented in percentage; where the higher the calculated value the better the REQ of the area under consideration. The interpretation scale of the model is as follows: Very good quality = above 70%; Good quality = 60-69%; Moderate quality = 50-59%; Poor quality = 40-49%; Very poor quality = below 40%.

4. Results and discussion

4.1 Respondents' demographic characteristics

A total of 392 (97.5%) of the 400 sets of the administered questionnaire were filled and returned. The responses to the questionnaire are presented in **Table 1**. The data showed that there were 222 (56.6%) males and 170 (43.4%) females, which adequately represents the views of both sexes. The age bracket with the highest frequency was 25-40 years, which accounts for 179 (45.7%) respondents, while above 65 years accounts for the lowest number (17) of respondents, which represents 3.8%. This shows that the age structure is youthful. However, the views of the various age strata of the population were accommodated. The data on marital status show that 185 (47.2%) respondents were married, while 160 (40.8%), 42 (10.7%) and 5 (1.3%) were single, divorced and widowed, respectively. The educational status showed that the majority (45.9%) of the respondents had tertiary education, while 42.9% and 11.2% had secondary and no formal/primary education, respectively. The income status of the re-

Table 1. Demographic characteristics of respondents.

Questionnaire variable	Response variable	Number of respondents	Percentage response
Sex	Male	222	56.6
	Female	170	43.4
Age	Below 25 years	100	25.5
	25-40 years	179	45.7
	41-65 years	98	25.0
	Above 65 years	15	3.8
Marital Status	Married	185	47.2
	Single	160	40.8
	Divorced	42	10.7
	Widow/Widower	5	1.3
Educational Status	No formal/Primary	44	11.2
	Secondary	168	42.9
	Tertiary	180	45.9
Monthly Income	Low (below N100,000)	247	63.0
	Middle (N100,000-N250,000)	120	30.6
	High (above N250,000)	25	6.4

Source: Authors' fieldwork, 2023.

spondents indicated that the majority of the population belongs to the low- and middle-income class; as 247(63%), 120 (30.6%) and 25 (6.4%), respondents earned below N100,000 (low income), 100,000-250,000 (middle income) and above N250,000 (high income), respectively. The data have shown that the sampled respondents adequately represented the various socioeconomic strata of the population.

4.2 Residential environmental quality indicators

In order to determine the REQ of Yenagoa metropolis, seven proxy indicators (air quality, drinking water quality, housing location, sanitation, waste management, housing accessibility and noise pollution) were selected and used for the assessment. Each of the seven indicators was graduated into a five-point Likert scale for respondents to rate accordingly as shown in **Table 2**. A quality weight value ranging from 1-5 was assigned to each of the sub-items of the respective seven indicators, based on their assumed importance in contributing to the REQ. Value 1, represents very poor quality and 5 very good quality. The integration of the ratings of the seven REQ indicators by the respondents produced the PREQ of the Yenagoa metropolis. The calculated REQ is presented in percentage as indicated in the method of study. The higher the percentage value the higher the PREQ.

Air quality

Air quality (AQ) was selected as one of the indicators for the assessment of the REQ of Yenagoa because it constitutes serious environmental threats to human health, which could increase the burden of diseases such as respiratory tract infections, lung cancer and asthma. In fact, air pollution was estimated to be responsible for the premature death of 4.2 million people globally in 2016 ^[22]. The assessment of residential AQ by the respondents was done based on five sub-elements, which were assigned quality weight values ranging from 1-5. Five, represents very good quality, while 1 represents very poor quality as shown in **Table 2**. The response shows that the majority (28.1%) of the respondents per-

ceived the environmental AQ as acceptable but with moderate risk for people who are usually sensitive to air pollution, which was rated moderate, with a quality weight value of 3. However, 12 (3%) of the respondents perceived the air quality as very unacceptable, as the risk of health effects is increased for everyone, hence, it was assigned a quality weight of 1 (very poor quality). In all, only 44.7% of the respondents perceived the air quality as either good or very good. This may indicate that the majority of the population is exposed to the threat of air pollution. This response is not surprising because it has been reported that in 2019, about 99% of the global population lived in areas that failed to meet the WHO guidelines on air quality ^[22]. This assertion confirms a 2009 study of the “concentrations of air pollutants in Yenagoa and environs,” which reported that the concentration of all the studied pollutants except hydrogen sulphide exceeded the permissible thresholds recommended by the Federal Ministry of Environment and therefore constitute serious health threats ^[23].

Drinking water quality

Drinking water quality (DWQ) was selected as one of the REQ indicators because it is a major component of the environment and is needed for the sustenance of life. Several studies have established the role of safe drinking water in the prevention of different types of diseases, especially diarrhea, which has been identified as one of the major killers of children below the age of 5 ^[24]. The perception of the DWQ was based on the major source of drinking water used by the respondents. As earlier noted in the method of study, this indicator was classified into five categories and was assigned quality weight values. The data as shown in **Table 2** revealed that the highest responses (40.6%) had access to drinking water from safe sources, which were accessible on premises and whenever needed. This was considered the best water source and was assigned a 5-point quality weight; while the lowest response of 4.5% was recorded for those who still obtain their drinking water from surface sources such as rivers, dams, lakes, ponds, canal or irrigation canal, which is the worst supply source for drinking water. This figure is

Table 2. Response to residential environmental quality indicators.

S/N	Environmental quality indicator	Quality weight (q _{i-s})	Response (f)	Percentage (%)
1	Air Quality			
A	Air quality is satisfactory, and air pollution poses no risk	5	72	18.4
B	Air quality is acceptable but with little risk for people who are unusually sensitive to air pollution	4	103	26.3
C	Air quality is acceptable but with moderate risk for people who are usually sensitive to air pollution	3	110	28.1
D	Air quality unacceptable as some members of the general public may experience health effects; while sensitive groups may experience more serious health effects.	2	95	24.2
E	Air quality very unacceptable, as the risk of health effects is increased for everyone	1	12	3.0
2	Drinking Water Quality			
A	Drinking water from safe sources, accessible on premises and whenever needed	5	159	40.6
B	Drinking water from safe sources but not accessible on premises, provided collection time is not more than 30 minutes	4	89	22.7
C	Drinking water from safe sources but not accessible on premises and collection time is more than 30 minutes	3	96	24.5
D	Drinking water from unsafe sources such as unprotected dug well or spring	2	30	7.7
E	Drinking water from surface water sources such as river, dam, lake, pond, stream, canal or irrigation canal	1	18	4.5
3	Housing location			
A	Free from all kinds of floods	5	46	11.7
B	Low flood risk	4	139	35.5
C	Moderate flood risk	3	111	28.3
D	High flood risk	2	61	15.6
E	Severe flood risk	1	35	8.9
4	Sanitation facility			
A	Safely managed sanitation facility that is not shared, disposed in situ or treated off-site	5	32	8.2
B	Use of improved sanitation facility that is not shared with other households	4	180	45.9
C	Use of improved sanitation facility that is shared with two or more households	3	134	34.2

Table 2 continued

S/N	Environmental quality indicator	Quality weight (q _{1-s})	Response (f)	Percentage (%)
D	Use of pit latrines without a slab or platform, hanging latrines or bucket latrines	2	41	10.5
E	Open defecation	1	5	1.3
5	Waste Management			
A	All forms of waste are adequately disposed safely in a designated place and evacuated promptly	5	44	11.2
B	All forms of waste are adequately disposed safely in a designated place but not promptly evacuated.	4	11	28.1
C	Some forms of waste are inadequately disposed due to insufficient disposal facilities and are poorly evacuated.	3	15	39.3
D	Most forms of waste are very inadequately disposed due to poor disposal facilities and are poorly evacuated.	2	64	16.3
E	Indiscriminate disposal of all forms of waste on wetlands, bushes, roads or rivers.	1	20	5.1
6	Housing Accessibility			
A	Adequately accessible to all forms of road transportation	5	86	21.9
B	Fairly accessible to all forms of road transportation	4	173	44.1
C	Poorly accessible to some forms of road transportation	3	96	24.5
D	Not accessible to some forms of road transportation	2	27	6.9
E	Not accessible to most forms of road transportation	1	10	2.6
7	Noise Pollution			
A	Environment is quiet, serene and free from any form of noise pollution	5	30	7.7
B	Environment is fairly quiet with very low risk of noise pollution	4	94	24.0
C	Environment is moderately quiet with low risk of noise pollution	3	140	35.7
D	Environment is disturbed with high risk of noise pollution	2	86	21.9
E	Environment is disturbed with severe risk of noise pollution.	1	42	10.7

* Quality weight: 5 = Very good; 4 = Good; 3 = Moderate; 2 = Poor; 1 = Very poor.

Source: Authors' fieldwork, 2023.

in line with the 6% estimates for Nigeria in 2020 ^[25].

In spite of the global efforts toward achieving the sustainable development goals (SDGs), target 6.1, it was observed that 12.2% of the respondents still used unimproved sources of drinking water, which exposes those using these sources to serious health challenges and pose some problems to the actualiza-

tion of the SDG 6.1 target. Although 87.8% of the respondents had access to safe drinking water sources, however, 24.5% still spent more than 30 minutes on a return journey for fetching drinking water from their major sources, which is beyond the WHO and UNICEF thresholds of less than 30 minutes. **Plate 1** shows a typical water vending point in Yenagoa.



Plate 1. A typical water vending point at Okutukutu.

Source: Authors' fieldwork, 2023.



Plate 2. Poorly spaced houses and location at Agudama.

Source: Authors' fieldwork, 2023.

Housing location

Responses to housing location (HL) show that only 11.7% of the respondents live in houses that were free from all kinds of floods; while the remaining 88.3% experience one form of flood or the other. Of this number, 24.5% experience either high or severe flood risk as revealed in **Table 2**. The responses agreed with the recent flood episodes (2012 & 2022) experienced in Yenagoa, where over 50% of the built up areas were affected. This assertion agrees with the study that reported that about 48% of Yenagoa experiences moderate to high risk of flooding ^[26].

The location of a residential building to a large extent influences human health, QoL and socio-economic activities ^[27]. Those whose houses are located in flood-prone areas are usually subjected to untold hardships, occasioned by frequent floods that cause serious dislocation to their normal lifestyle, health and well-being. In fact, floods in Yenagoa have led to the loss of lives, properties, and farmlands, disruption of academic activities, social functions and economic livelihoods of the people ^[28]. In spite of the impact of floods in the city, people still build on flood plains and poorly reclaimed wetlands due to scarcity of land, poor economic status of the people, high population growth rate and poor development control ^[20]. This situation has led to the development of slums in part of the city, which has created congestion with little spaces between houses. This congestion could result in the rapid spread of infectious diseases in the city in case of an outbreak. **Plate 2** is an example of some of the poorly located houses in Yenagoa.

Sanitation

Sanitation is an important component of the Sustainable Development Goal 6, which has been recognized as an important factor in promoting good health ^[25,29,30]. The responses to sanitation as presented in **Table 2** showed that 88.2% of the respondents either have access to improve or safely managed sanitation facilities (see **Plate 3**). However, 34.2% of this proportion used shared facilities with two or more families, which is classified as limited sanitation ^[18]. In spite of the global efforts to end open defecation (OD), 1.3% of the respondents still practice this worst form of sanitation. This is however better than the 18% average for sub-Saharan Africa (SSA) in 2020. The ultimate goal of SDG target 6.2a is to ensure that everyone has access to safely managed sanitation facilities. This goal is still far from being achievable in Yenagoa by 2030, as only 8.2% of the respondents had access to safely managed sanitation services.



Plate 3. A safely managed sanitation facility at Onopa.

Source: Authors' fieldwork, 2023.

Waste management

Waste of different types and compositions could have adverse effects on people if not well disposed of or managed. Several studies have reported that poor waste management (WM) could lead to water, soil and air pollution, poor QoL and health challenges, such as diarrhea, cholera and cancer ^[4,31,32]. It can also constitute both social and psychological effects on people as it is unsightly and produce an offensive odour; hence its inclusion as an indicator in the assessment of REQ of Yenagoa. The responses to WM (**Table 2**) revealed that 11.2% of the respondents indicated that all forms of waste are adequately disposed of safely in a designated place and evacuated promptly (see **Plate 4**). However, the majority (39.3%) of the respondents indicated that some forms of waste are inadequately disposed of due to insufficient disposal facilities and are poorly evacuated. Sadly, 5.1% of the respondents reported indiscriminate disposal of all forms of waste on wetlands, bushes, roads or rivers. This agrees with the submission that in some local government areas of Ogun State there was a lack of waste disposal facilities in some of the communities ^[33]. This situation encourages indiscriminate disposal of waste, which may pose a serious threat to human life.



Plate 4. Solid waste evacuation at Yenizue-Epie.

Source: Authors' fieldwork, 2023.

Housing accessibility

Good accessibility is fundamental to a quality residential home because it facilitates social interactions, easy rescue and evacuations of households during emergencies and freedom to move in and

out freely. Response to housing accessibility (HA) showed that the majority (44.1%) of the respondents indicated that their homes were fairly accessible to all forms of road transportation, while 21.9% indicated that their houses were adequately accessible to all forms of road transportation. However, 34% of the respondents live in houses that are either poorly or not accessible to some forms of road transportation or not accessible to most forms of road transportation (see **Plate 5**). This is a clear manifestation of poor urban control and planning in Yenagoa. From physical observation in the field, it could be seen that buildings are erected in some locations indiscriminately, with some buildings blocking the right of way to other buildings. In some cases, the buildings are so close to each other that there is hardly enough space for even a motorcycle to pass through easily. These findings agree with the submission that houses in parts of Yenagoa are built haphazardly leading to overcrowding in spite of existing building laws ^[34].



Plate 5. Earth road linking residential neighbourhood off Imirigi Road.

Source: Authors' fieldwork, 2023.

Noise pollution

Noise pollution (NP) has been known to constitute serious problems such as hearing impairment; high blood pressure; cognitive difficulties; mental health and insomnia ^[35-38]. However, it has not received much attention compared to other forms of

pollution (air, water & soil). Because of the impacts of noise pollution, it was selected as one of the indicators for REQ. **Table 2** reveals that 32.6% of the respondents are exposed to high or severe risk of noise pollution; while only 7.7% indicated that their environment was quiet, serene and free from any form of noise pollution. Furthermore, 59.7% indicated that their environment was either fairly or moderately quiet with a very low or low risk of noise pollution. The major sources of noise pollution in Yenagoa from the direct field observation are music stores, vehicular movement, generators, construction works and religious activities. This finding agrees with that of Oguntunde et al. ^[39].

4.3 Calculated rating of REQ of Yenagoa

In order to determine the overall rating of the REQ of Yenagoa based on the respondents' perception, the data in **Table 2** and the REQ model, defined in the method of the study were used and the calculated values were presented in **Table 3**. From the table, the calculated total weighted quality rating of the seven indicators ranged from 1160 to 1517 points. The indicator with the best rating was drinking water quality, while noise pollution had the worst rating. This implies that noise pollution constitutes a serious environmental threat to the residents. Unfortunately, noise pollution has not received much attention

compared to other forms of pollution in Yenagoa. Following closely to noise pollution were sanitation and housing location, which had 1270 and 1276 points, respectively. The calculated total weighted quality rating value of the seven indicators was 9370 points, with a total response (TR) of 2744. Based on the model specification, the calculated residential environmental quality index (reqi) was 3.41 points. Substituting this value into the model, the overall rating of the REQ of Yenagoa was 68.2%. Based on the interpretation scale, the respondents have rated the REQ of Yenagoa as "good quality".

$$REQ = \frac{reqi}{hq} \times \frac{100}{1} = \frac{3.41}{5} \times \frac{100}{1} = 68.2\%$$

Rating of REQ by sex, income and education status

In order to assess the influence of respondents' sex, income and education statuses on their rating of the REQ indicators, separate analyses were conducted for each of these three factors. The sex analysis revealed that the calculated reqi of each of the seven indicators ranges from 2.96 to 3.85 points with a mean value of 3.40 points; while that of the female ranges from 2.90 to 3.75 points with a mean value of 3.38 points. For the male respondents, waste management had the best rating and noise pollution was the worst. For the females, both air quality and

Table 3. Calculated rating of residential environmental quality of Yenagoa.

SN	Environmental quality indicator	Weighted quality rating $q_5(f)$	Weighted quality rating $q_4(f)$	Weighted quality rating $q_3(f)$	Weighted quality rating $q_2(f)$	Weighted quality rating $q_1(f)$	Total weighted quality rating $\Sigma q_{1-5}(f)$	Total response (TR)
1	Air quality	360	412	330	190	12	1,304	392
2	Drinking water quality	795	356	288	60	18	1,517	392
3	Housing location	230	556	333	122	35	1,276	392
4	Housing Accessibility	160	720	402	82	5	1,369	392
5	Sanitation facility	220	440	462	128	20	1,270	392
6	Waste management	430	692	288	54	10	1,474	392
7	Noise pollution	150	376	420	172	42	1,160	392
8	Total	2,345	3,552	2,523	808	142	9,370	2,744
Residential environmental quality index (reqi) = 9370/2744 = 3.41								

drinking water quality had the highest rating of 3.75 points each, while noise pollution had the lowest rating just as the male rating. The calculated values of the REQ were 68% and 67.6%, for male and female respondents, respectively (see **Table 4**). The result of the t-test analysis ($t_6 = 0.237$, $p = 0.821$ at $\alpha = 0.05$) clearly shows that there was no significant difference in the perception of REQ of Yenagoa by sex.

The calculated reqi of each of the seven indicators by income status of respondents as shown in **Table 5** revealed that low-income earners' rating ranges from 2.74 to 3.82 points with a mean value of 3.36 points. The highest-rated indicator was drinking water quality, while the lowest-rated indicator was housing location with a mean value of 3.36 points.

The range for medium income was 2.77-4.06 points. The highest value was for drinking water quality and the lowest value was housing location, with a mean value of 3.49 points. For high income, it ranged from 2.68 to 4.00 points. The highest value was for air quality, while the lowest was for housing location and a mean value of 3.40 points. The calculated values of the REQ were 67.2%, 69.8% and 68%, for low-income, middle-income and high-income earners, respectively. These results show that middle-income earners had the highest quality rating of their residential environment. However, the result of the ANOVA test ($F = 0.127$, $p = 0.881$ at $\alpha = 0.05$) revealed that there was no significant variation in the perception of REQ of Yenagoa by income status of

Table 4. Calculated residential environmental quality index by sex.

S/N	Rating indicators	Sex	
		Male (n = 222)	Female (n = 170)
1	Air quality	3.48	3.75
2	Drinking water quality	3.81	3.75
3	Housing location	3.06	3.15
4	Housing accessibility	3.34	3.36
5	Sanitation facility	3.29	3.13
6	Waste management	3.85	3.65
7	Noise pollution	2.96	2.90
8	Mean residential environmental quality index (reqi)	3.40	3.38
9	Residential environmental quality (REQ)	68%	67.6%

Source: Authors' fieldwork, 2023.

Table 5. Calculated rating of residential environmental quality by income.

S/N	Rating indicators	Income status		
		Low Income (Below N100,000) n = 247	Medium Income (N100,000-N250, 000) n = 120	High Income (Above N250, 000) n = 25
1	Air quality	3.57	3.80	4.00
2	Drinking water quality	3.82	4.06	3.96
3	Housing location	2.74	2.77	2.68
4	Housing Accessibility	3.45	3.61	3.76
5	Sanitation	3.24	3.01	2.92
6	Waste management	3.77	3.86	3.68
7	Noise pollution	2.95	3.33	2.80
8	Mean residential environmental quality index (reqi)	3.36	3.49	3.40
9	Residential environmental quality (REQ)	67.2%	69.8%	68%

Source: Authors' fieldwork, 2023.

respondents. The insignificant variation was further confirmed by the results of the post hoc test using the Least Square Deviation (LSD) at the 5% level of confidence.

The calculated rating of each of the seven reqi by no formal/primary school respondents as shown in **Table 6** ranges from 2.36 to 3.18 points. Noise pollution was the least rated, while housing location had the highest rating with a mean value of 2.91 points. Rating by those with secondary education ranges from 2.54 to 3.82 points with a mean value of 3.34 points; while the rating by those with tertiary education ranges from 3.31 to 4.01 with a mean value of 3.60. The calculated REQ by education status was 58.2%, 66.8% and 72% for no formal/primary education, secondary education and tertiary education, respectively. This rating is an indication that those with the lowest education status reside in low quality environment. Hence, the ANOVA result ($F = 6.787$, $p = 0.006$ at $\alpha = 0.05$) showed that there was a significant variation in the perception of the REQ of Yenagoa by education status. The post hoc test using the LSD showed that the mean differences were significant at the 5% level of confidence between no formal/primary and secondary, as well as between no formal/primary and tertiary respectively. However, the observed mean difference between secondary and tertiary is insignificant at the 5% level of confidence. From the results of the t-test and ANOVA, it is quite evident that the level of respondents' education ex-

erts a major influence on the perception of the REQ of Yenagoa.

Rating of REQ by zone (Neighbourhood)

In addition to the calculated REQ by sex, income and education status, the REQ of the four classified zones was also calculated. From the results presented in **Figure 2**, the calculated reqi for AQ across the zones were as follows: Zone A, 3.50 points; Zone B, 3.55 points; Zone C, 3.60 points and Zone D, 3.69 points. The calculated reqi for DWQ was relatively high in the four zones but highest in Zone B and lowest in Zone C. The DWQ was the highest-rated quality indicator in each of the four zones. For HL, Zone A recorded the lowest value (2.70), while Zone C recorded the highest (3.19). The probable reason for the low rating in Zone A may be attributed to the fact that large areas of the zone is usually heavily inundated during the annual floods. The level of housing accessibility across the zones ranged from 3.29 (Zone B) to 3.40 (Zone C). The difference between the lowest and highest range was just 0.11 points. This is so because across the zones a large number of the housing stocks are connected with roads that are tarred or not tarred. The rating of sanitation facilities was fairly good across the zones as the range was 3.20 (Zone D) to 3.38 (Zone C). This shows that over half of the population in each zone has access to improved sanitation facilities. This assertion is substantiated by an earlier study in Yenagoa, which reported that 53% of the population in Yenagoa has

Table 6. Calculated rating of residential environmental quality by education status.

S/N	Rating indicators	Education status		
		No Formal/ Primary (n = 44)	Secondary (n = 168)	Tertiary (n = 180)
1	Air quality	2.84	3.50	3.90
2	Drinking water quality	3.14	3.70	4.01
3	Housing location	3.18	3.16	3.31
4	Housing accessibility	3.05	3.43	3.57
5	Sanitation facility	2.66	3.26	3.36
6	Waste management	3.11	3.82	3.89
7	Noise pollution	2.36	2.54	3.17
8	Mean residential environmental quality index (reqi)	2.91	3.34	3.60
9	Residential environmental quality (REQ)	58.2%	66.8%	72%

Source: Authors' fieldwork, 2023.

access to improved sanitation facilities ^[11]. Waste management across the zones received a fairly good rating as the reqi ranged from 3.52 (Zone B) to 3.65 (Zone A). However, during the fieldwork it was observed by the researchers that some waste receptacles were not promptly evacuated, making them constitute a menace in the immediate environment, which flies and rodents have turned into breeding grounds. Such a situation could constitute a serious threat to environmental health. The range of the calculated reqi for NP was 2.98 (Zone A) to 3.10 (Zone B). Compared to the other quality indicators, NP received the lowest rating in Zones B, C and D; while it was the second lowest in Zone A after HL. This shows that the respondents considered NP as a serious environmental threat across the zones. Similar results were also reported in a study of three cities where noise and security were considered major indicators affecting their QoL ^[9].

In order to have an overall rating of the respective zones based on the seven quality indicators the REQ

of each of the zones was calculated and the results were shown in **Figure 3**. From the figure, the REQ of the zones ranged from 66.4% (Zone A) to 68.4% (Zone C). Although based on the interpretation scale, the four zones calculated REQ fell within the “good quality” classification, however, Zone C respondents had the best perception of their environmental quality, while Zone A respondents had the worst perception. These findings could guide policy development by relevant government agencies to further improve the quality of the environment.

5. Conclusions

The study established that the perceived REQ of Yenagoa was high, with an overall calculated score of 68.2%, which was classified as “good quality” based on the model specifications. Drinking water quality was best-rated REQ indicator, while noise pollution was the least-rated indicator. This shows that noise pollution exerts serious environmental

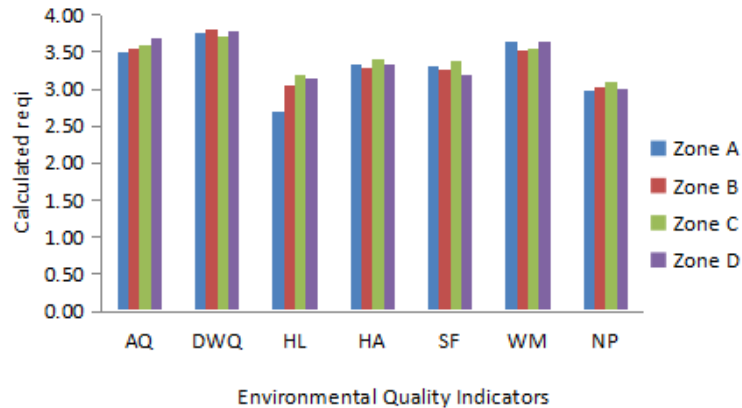


Figure 2. Calculated residential environmental quality index by zone.

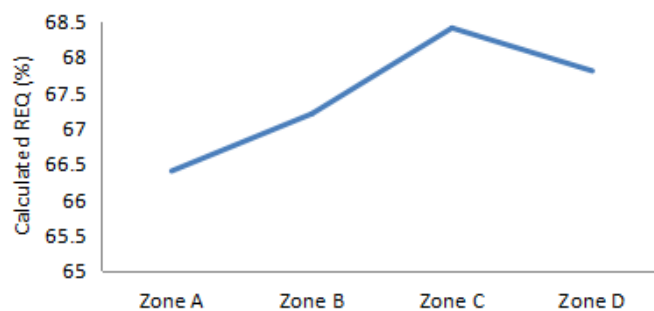


Figure 3. Calculated residential environmental quality by zone.

pressure on the inhabitants, but has received little attention. The REQ rating based on sex, income and education status of the respondents also recorded similar scores. The t-test analysis revealed that there was no significant difference in the perception of the REQ between male and female respondents; while the ANOVA analysis by income status indicated that there was no significant variation in the perception by income status (low, middle & high); while that of education status (no formal/primary, secondary & tertiary) indicated that there was significant variation. However, the post hoc test using the LSD showed that no variation exists between the perception of the REQ by respondents with secondary and tertiary education status. These analyses demonstrate a general consensus that the REQ of Yenagoa was high based on the selected indicators. However, there is still room for improvement especially in the area of noise pollution, sanitation and housing location, which received relatively lower ratings.

Author Contributions

Author OO designed the study, and wrote the first draft; while author DOE conducted the analysis, edited the first draft and both authors read and approved the final draft.

Conflict of Interest

The authors declare that there is no conflict of interest.

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References

[1] The 2018 Revision of the World Urbanization Prospects [Internet]. United Nations Department

of Economic & Social Affairs; 2018. [cited 2023 Apr 10]. Available from: <https://www.un.org/development/desa/en/news/population/2018-revision-of-world-urbanization-prospects.html>

- [2] Parra, D.C., Gomez, L.F., Sarmiento, O.L., et al., 2010. Perceived and objective neighborhood environment attributes and health related quality of life among the elderly in Bogota, Colombia. *Social Science & Medicine*. 70(7), 1070-1076. DOI: <https://doi.org/10.1016/j.socscimed.2009.12.024>
- [3] Gruebner, O., Rapp, M.A., Adli, M., et al., 2017. Cities and mental health. *Deutsches Ärzteblatt International*. 114(8), 121.
- [4] Phan, L.T., Nguyen, G.T., Nguyen, Q.A.D., et al., 2021. Quality of life and factors affecting it: A study among people living near a solid waste management facility. *Frontiers in Public Health*. 9, 720006. DOI: <https://doi.org/10.3389/fpubh.2021.720006>
- [5] Mao, Y., Luo, X., Guo, S., et al., 2022. Validation of the abbreviated indicators of perceived residential environment quality and neighborhood attachment in China. *Frontiers in Public Health*. 10, 925651-925651. DOI: <https://doi.org/10.3389/fpubh.2022.925651>
- [6] Zhang, L., Yang, Y., Lin, Y., et al., 2022. Human health, environmental quality and governance quality: Novel findings and implications from human health perspective. *Frontiers in Public Health*. 10, 890741. DOI: <https://doi.org/10.3389/fpubh.2022.890741>
- [7] Herrera, C., Cabrera-Barona, P., 2022. Impact of perceptions of air pollution and noise on subjective well-being and health. *Earth*. 3(3), 825-838. DOI: <https://doi.org/10.3390/earth3030047>
- [8] Bonaiuto, M., Fornara, F., 2017. Residential satisfaction and perceived urban quality. *Reference Module in Neuroscience and Biobehavioral Psychology*. 1-5. DOI: <http://dx.doi.org/10.1016/B978-0-12-809324-5.05698-4>
- [9] Hanák, T., Marović, I., Aigel, P., 2015. Perception of residential environment in cities: A comparative study. *Procedia Engineering*. 117, 495-

- 501.
- [10] Chu, M.T., Fenelon, A., Rodriguez, J., et al., 2022. Development of a multidimensional housing and environmental quality index (HEQI): Application to the American Housing Survey. *Environmental Health*. 21(1), 56.
DOI: <https://doi.org/10.1186/s12940-022-00866-8>
- [11] Toma, A., Hamer, M., Shankar, A., 2015. Associations between neighborhood perceptions and mental well-being among older adults. *Health & Place*. 34, 46-53.
DOI: <https://doi.org/10.1016/j.healthplace.2015.03.014>
- [12] Gao, M., Ahern, J., Koshland, C.P., 2016. Perceived built environment and health-related quality of life in four types of neighborhoods in Xi'an, China. *Health & Place*. 39, 110-115.
DOI: <https://doi.org/10.1016/j.healthplace.2016.03.008>
- [13] Roster, C.A., Ferrari, J.R., Jurkat, M.P., 2016. The dark side of home: Assessing possession 'clutter' on subjective well-being. *Journal of Environmental Psychology*. 46, 32-41.
DOI: <https://doi.org/10.1016/j.jenvp.2016.03.003>
- [14] Terwase, S., Theresa, S.U., 2013. Residents' perception of environmental quality in judges quarters of Makurdi Town, Nigeria. *Journal of Human and Social Science Research*. 1(1), 39-49.
- [15] Zhou, K., Tan, J., Watanabe, K., 2021. How does perceived residential environment quality influence life satisfaction? Evidence from urban China. *Journal of Community Psychology*. 49(7), 2454-2471.
DOI: <https://doi.org/10.1002/jcop.22545>
- [16] Bonaiuto, M., Fornara, F., Bonnes, M., 2003. Indexes of perceived residential environment quality and neighbourhood attachment in urban environments: A confirmation study on the city of Rome. *Landscape and Urban Planning*. 65(1-2), 41-52.
DOI: [https://doi.org/10.1016/S0169-2046\(02\)00236-0](https://doi.org/10.1016/S0169-2046(02)00236-0)
- [17] Mao, Y., Peng, C., Liang, Y., et al., 2022. The relationship between perceived residential environment quality (PREQ) and community identity: Flow and social capital as mediators. *Social Indicators Research*. 163(2), 771-797.
DOI: <https://doi.org/10.1007/s11205-022-02915-8>
- [18] Ohwo, O., 2019. Analysis of households' vulnerability to waterborne diseases in Yenagoa, Nigeria. *Journal of Water, Sanitation and Hygiene for Development*. 9(1), 71-79.
- [19] Ohwo, O., 2016. Residents' perception of urban aesthetics of Yenagoa, Bayelsa State, Nigeria. *Nigerian Geographical Journal, New Series*. 11(1), 93-104.
- [20] Ohwo, O., 2014. Housing quality in Yenagoa, Bayelsa State, Nigeria. *Nigerian Geographical Journal, New Series*. 10(1), 53-67.
- [21] Krejcie, R.V., Morgan, D.W., 1970. Determining sample size for research activities. *Educational and Psychological Measurement*. 30(3), 607-610.
- [22] Ambient (outdoor) Air Pollution [Internet]. WHO; 2021. [cited 2022 Dec 16]. Available from: <https://www.who.int/news-room/fact-sheets/detail/ambient-%28outdoor%29-air-quality-and-health>
- [23] Gobo, A.E., Ideriah, T.J.K., Osaisai, C.B., et al., 2009. Concentration of air pollutants in Yenagoa and environs, Nigeria. *International Journal of Environmental Science*. 5(3), 124-130.
- [24] Diarrhoeal Disease: Key Facts [Internet]. WHO; 2017. [cited 2023 Feb 10]. Available from: <https://www.who.int/news-room/fact-sheets/detail/diarrhoeal-disease>
- [25] Progress on Household Drinking Water, Sanitation and Hygiene 2000-2020: Five Years into the SDGs [Internet]. WHO, UNICEF; 2021. [cited 2023 Jan 1]. Available from: <https://apps.who.int/iris/handle/10665/345081>
- [26] Oladimeji, O.E., Ohwo, O., 2022. Assessment of flood risk and mapping of flood risk zones in Yenagoa, Bayelsa State, Nigeria. *Journal of Applied Sciences and Environmental Management*. 26(2), 219-226.
- [27] Braveman, P., Dekker, M., Egerter, S., et al.,

2011. Housing and Health [Internet] [cited 2022 Dec 22]. Available from: <https://www.rwjf.org/en/insights/our-research/2011/05/housing-and-health.html>
- [28] Ajumobi, V.E., Womboh, S.B., Ezem, S.B., 2023. Impacts of the 2022 flooding on the residents of Yenagoa, Bayelsa State, Nigeria. *Greener Journal of Environmental Management and Public Safety*. 11(1), 1-6.
- [29] Ohwo, O., Omidiji, A.O., 2021. Pattern of waterborne diseases in Yenagoa, Nigeria. *Journal of Applied Sciences and Environmental Management*. 25(6), 1015-1023.
- [30] Zerbo, A., Delgado, R.C., González, P.A., 2021. Water sanitation and hygiene in Sub-Saharan Africa: Coverage, risks of diarrheal diseases, and urbanization. *Journal of Biosafety and Biosecurity*. 3(1), 41-45.
- [31] Akmal, T., Jamil, F., 2021. Testing the role of waste management and environmental quality on health indicators using structural equation modeling in Pakistan. *International Journal of Environmental Research and Public Health*. 18(8), 4193.
DOI: <https://doi.org/10.3390/ijerph18084193>
- [32] Vergara, S.E., Tchobanoglous, G., 2012. Municipal solid waste and the environment: A global perspective. *Annual Review of Environment and Resources*. 37, 277-309.
- [33] Olukanni, D.O., Pius-Imue, F.B., Joseph, S.O., 2020. Public perception of solid waste management practices in Nigeria: Ogun State experience. *Recycling*. 5(2), 8.
DOI: <https://doi.org/10.3390/recycling5020008>
- [34] Ebakpa, A.F., Brisibe, W.G., 2019. Unintentional slum creation: Assessing housing development in selected inner city settlements of Yenagoa, Nigeria. *American Journal of Civil Engineering and Architecture*. 7(4), 181-189.
DOI: <https://doi.org/10.12691/ajcea-7-4-5>
- [35] Hinchcliffe, R., 2002. Global perspective of noise-induced hearing loss as exemplified by Nigeria. *Journal of Audiological Medicine*. 11(1), 1-24.
- [36] Ntui, A.I., 2009. Noise sources and levels at the University of Calabar Library, Calabar, Nigeria. *African Journal of Library, Archives & Information Science*. 19(1), 53-63.
- [37] Ebare, M.N., Omuemu, V.O., Isah, E.C., 2011. Assessment of noise levels generated by music shops in an urban city in Nigeria. *Public Health*. 125(9), 660-664.
DOI: <https://doi.org/10.1016/j.puhe.2011.06.009>
- [38] Freiberg, A., Schefter, C., Girbig, M., et al., 2019. Health effects of wind turbines on humans in residential settings: Results of a scoping review. *Environmental Research*. 169, 446-463.
DOI: <https://doi.org/10.1016/j.envres.2018.11.032>
- [39] Oguntunde, P.E., Okagbue, H.I., Oguntunde, O.A., et al., 2019. A study of noise pollution measurements and possible effects on public health in ota metropolis, Nigeria. *Open Access Macedonian Journal of Medical Sciences*. 7(8), 1391.
DOI: <https://doi.org/10.3889/oamjms.2019.234>

EDITORIAL

Strengthening People-oriented Geographical Research in the New Era

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We are going through an era of rapid change. In the past three hundred years, with the development of the industrial revolution, social structure and urbanization have allowed geography to play a unique perspective in studying human-land relations, depicting how humans constantly adapt to environmental changes, forming the focus of geographical research at different times. When people face various problems, such as global resource crises, environmental pollution, and urban development, they find it difficult for sub-disciplines to solve problems independently. Therefore, how to promote sustainable development has become a core topic of concern for geographers, and the unity and comprehensiveness of geography have once again attracted people's attention. In the current development context, it becomes the core topic that how to meet human needs and sustainable development of the natural environment. That is, strengthening people-oriented geographical research and exploring the harmonious

coexistence between humans and nature has become an important direction of geography research.

The Earth's environment is complex and ever-changing, and the ability of humans to perceive and adapt to the surroundings requires enhanced research. That is to say, researchers not only need to study the complex natural appearance, structure, and formation process of the Earth itself, but also pay attention to human needs and environmental perceptions. In addition to being interested in natural geography, people have gradually begun to pay attention to their surrounding environment, landscape, and space, such as the adaptation of human behavior to the environment, human activities, and landscape changes.

Modern geography is a revolution in modern science and technology that continues to mature. Not only the rise of scientific methodologies such as information theory, system theory and cybernetics, but also the emergence of computer systems, remote

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sensing systems and geographic information systems. This provides more perspectives for geography to observe the distribution of socio-cultural phenomena and the spatial pattern of interaction between human beings and life systems, which is the problem that “location tradition and spatial analysis” should face ^[1]. To be specific, modern geography is increasingly integrating quantitative analysis, spatial analysis, ethnography analysis, etc. to study the interaction between human beings and the environment and the spatio-temporal change pattern. Enriching and improving the research of people-oriented geography is to summarize the adaptation methods of different ethnic groups to the natural and human environment based on the current development reality of various countries and regions in order to study the structure of humans and the environment, as well as the relationship between them.

The several articles in this issue fully reflect the editorial team’s new focus on geography research, which is the “people-oriented” approach to geography research. The author Angel Paniagua wants to establish the emotional or more personal dimensions that do not usually appear in research papers, through the Latour concept of philosophy of science of laboratory life, the life course of a (geo) ethnographer researcher is analyzed ^[2]. Undoubtedly, using the life history of ethnography researchers is not only the embodiment of the people-oriented research paradigm, but also the text mining of ethnography, which is not paid much attention to at ordinary times. Another article worth recommending is Odaifvwotu Ohwo’s ^[3] article on the perception of urban residential environmental quality. The author completed 400 questionnaire surveys and compared and analyzed the results of four regions based on the respondents’ gender, income, and educational status. Another hot topic article, of course, is rural revitalization, which is another national strategy implemented by China after comprehensive poverty alleviation ^[4]. A comprehensive spatio-temporal heterogeneity research index system of rural revitalization performance is also constructed, reflecting the focus on rural revital-

ization performance and a humanistic concern.

Geography is an ancient and complex discipline that requires increasing attention to people’s life experiences, environmental perceptions, and satisfaction in modern geography research. The *Journal of Geographical Research* strives to open a window for readers to explore the study of human-land relations in the new era, showcasing the latest results of analysis and argumentation on various aspects closely related to our lives from a geographical perspective. By comparing and analyzing the changes in lifestyles, analyzing the evolution of human-land relationships and spatial patterns around the world, we can better understand the deconstruction and improvement of living environments by geography, and better coexist in harmony with nature and the Earth. Geography’s research focus on the study of human society and the environment through the perspectives of place, space, and scale is finding increased relevance in fields ranging from ecology to economics ^[5].

This journal adheres to the principles of openness, inclusiveness, and sharing, and welcomes submissions, exchanges, and cooperation from scholars all over the world. We also look forward to more scholars paying attention to people-oriented geography research, using different research perspectives and methods to analyze and depict our complex world. With the goal of improving quality of life and satisfaction with the living environment, we quantitatively analyze and study the matching relationship between our living environment and human needs, revealing the mechanism and optimization path of the interaction between humans and the environment. Let’s work together and look forward to sharing more and better articles with everyone.

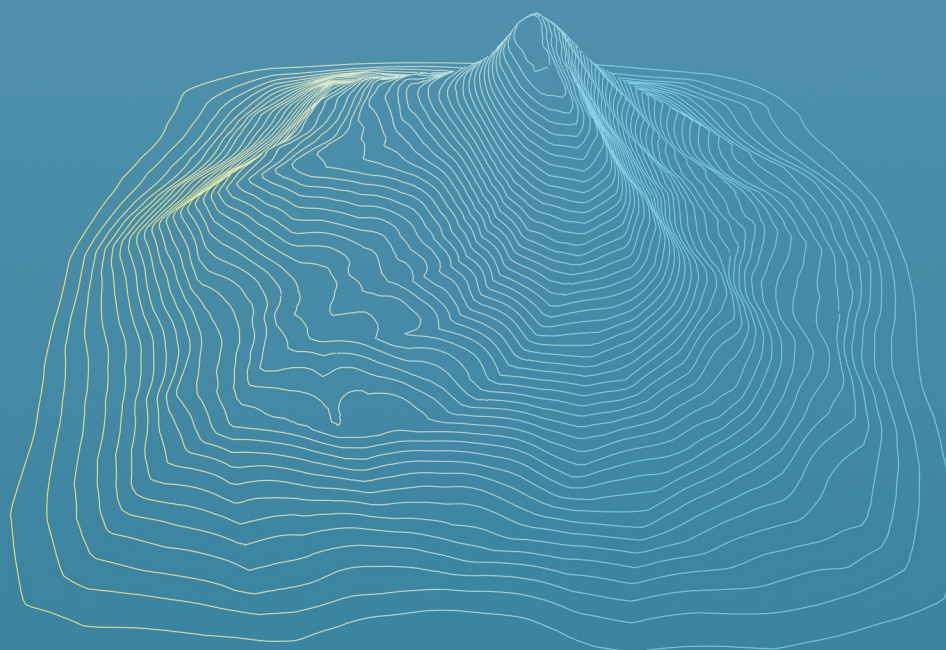
Conflict of Interest

There is no conflict of interest.

References

- [1] Getis, A., Getis, J., Fellmann, J.D., 2017. Intro-

- duction to geography, 15 edition. McGraw-Hill College: New York.
- [2] Paniagua, A., 2023. Laboratory life: Twenty years of experimental research with locals and new comers in remote rural areas. *Journal of Geographical Research*. 6(2), 1-14.
DOI: <https://doi.org/10.30564/jgr.v6i2.5587>
- [3] Ohwo, O., Ejemeyovwi, D.O., 2023. Perception of the residential environmental quality of Yenagoa Metropolis, Nigeria. *Journal of Geographical Research*. 6(2), 48-65.
DOI: <https://doi.org/10.30564/jgr.v6i2.5658>
- [4] Li, J., Li, J., Zhang, P., 2023. Spatio-temporal heterogeneity in the performance of rural revitalization in Chifeng City of China: Based on a range-wide EBM-GML model. *Journal of Geographical Research*. 6(2), 15-33.
DOI: <https://doi.org/10.30564/jgr.v6i2.5524>
- [5] National Research Council (U. S.), 1997. Rediscovering geography: New relevance for science and society. National Academy Press: Washington, D.C.



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