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RESEARCH ARTICLE

Structured timeline mapping as a data collection methodology: a new perspective for research on environmental adaptation

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ABSTRACT

The process of adaptation is dynamic and involves a temporal component. However, conventional methods of data collection have mostly been used in research on environmental adaptations and provide a rather static view. The structured timeline mapping method presented here is grounded in social sciences, designed for the West African environment, and constructed to capture time. The different steps for its construction and implementation are outlined along with the underlying reasoning that led to the choices made. It appears both respondents and interviewers benefit from this method since the recall process is facilitated for the first and the visual support gives a global view of the interview at all stages for the latter. Additionally, this methodology offers four major benefits. First, temporality is the central information collected, with both the timing and the duration of the elements. Second, this approach enables the observation of linkages and interrelations between adaptations or between adaptations and perceived changes in the environment. Third, the participants can self-reflect on their situation and bring elements to the analysis. Lastly, structured timeline mapping results in a more holistic view of the respondent's adaptation journey. Therefore, this data collection methodology provides a complementary view of the adaptation journey.

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Temporality; data collection methodology; adaptation; environmental change; northern Senegal

1. Introduction

Adaptation to environmental change will concern more and more households throughout the world (IPCC, 2022). Over the last decades, adaptation to environmental change has received increasing attention in research covering different regions of the world, different scales, and different economic occupations (Adger et al., 2005; Madhuri & Sharma, 2020; Vincent & Cundill, 2022). There seems to be a consensus that this topic should continue to receive extended attention and that empirical studies should be multiplied to gain a better understanding of the process of adaptation (Berrang-Ford et al., 2019). This implies that various data collection methodologies as well as various analysis methodologies are needed to cover the complexity of the adaptation process. It is in this vein that this article was written.

Most research uses traditional data collection methods, both quantitative (with questionnaires and models) and qualitative (with interviews and focus groups, among others). These methods are not criticized here and have their merits, but they often tend to give a static view of adaptation to environmental change. However, adaptation is defined as 'the process of adjustment to actual or expected climate and its effects' (IPCC, 2014). The word we are interested in here is 'process' which entails a more or less long period of time within which different actions or steps are undertaken. Time, while it seems central to adaptation according to its definition, has rarely been considered in research up until now[1]. Nevertheless, looking at temporality in adaptation to environmental and climate change can contribute to ongoing debates in the field. Such debates include among others discussions on how to incorporate time into research methodologies and on conceptualizing adaptation as a dynamic process. A first contribution of this method is to provide evidence on the timing of adaptation measures and on their effectiveness over time. In daily life, more or less spontaneous and planned adaptations coexist and interact, and should therefore be considered together (Castro & Sen, 2022). Second, the significant time spans provide insights into the advantages and disadvantages of different adaptation strategies in the context of specific environmental changes, providing valuable information on the feasibility of such strategies at very local scales (Gajjar et al., 2019). Third, by looking at incremental and transformative adaptation (Datta & Behera, 2022), temporality can provide a better understanding of how these adaptations occur over time, such as who adapts how and the potential evolution between strategies. This categorization of adaptation is based on the evolution of the production system, i.e. whether the system is maintained or fundamentally changed. Evolution evokes time, and thus temporality can provide new insights into this perspective. To give a recent example of how timeline mapping can be useful for policy design: in the health sector, timeline mapping was used to evaluate clinical decision support

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implementation and inform future strategies to reduce women veterans' cardiovascular risk (for more details see Brunner et al., 2022).

The aim of this article is to develop a new method of data collection centred on temporality in order to offer a new perspective in the field of research on adaptation to environmental change. Temporality is approached on the basis of the three analytical dimensions developed by Rosa (2013). The first dimension refers to the daily rhythms that organize social life such as daily routines. The second dimension refers to the expectations that individuals and societies project into the future and that shape different stages of life. The last dimension refers to the temporal embedding in a broader context, including historical, social, and cultural dimensions. Temporality is thus multifaceted and shapes human experience and social life. The structured timeline method is interested not only in individual temporalities, but also in how they are interconnected and embedded in a broader context. Such a method is rooted in the social sciences, a field in which temporality has been studied more extensively for other contexts and purposes. The timeline mapping methodology has then been adapted to a structured version and is suited to the context of a village in Western Africa. In order to meet this objective, this paper will start by giving a brief overview of how temporality has been included in adaptation to environmental change studies. How human memory works will then be addressed to understand and identify mechanisms to ease data collection. The different mechanism implemented to collect trustworthy data will also be detailed. These mechanisms are at the basis of the methodological design. Subsequently, the structured timeline mapping method will be presented, detailing how it is constructed and how it is implemented on the field, based on a case study in Northern Senegal. This paper will end with a discussion and conclusion on the new perspectives and benefits of this method.

2. Review of temporality collection and of human memory in data collection

This section starts by giving an overview of the use of timelines, going beyond the research field of environmental adaptations as the present methodology is rooted in the social sciences. Attention will then be given to the different methods that are used by researchers within the adaptation framework and how they evolved to collect time-related data. Finally, how human memory works, how this has an impact on data collection, and what mechanisms have been implemented in response will be addressed.

a. Temporality in adaptation to environmental change methodologies

Forms of timelines and the inclusion of temporality have been used for several decades and in different domains. In the United States, economists have been interested in the role of time in social accounting systems but also in behavioural models of market and nonmarket activities (Juster & Stafford, 1991). In parallel and outside of the US, sociologists and statisticians have looked at the differences among societal groups and focused on time spent on nonmarket activities embedded in the household (ibid.). To study these subjects, researchers had to develop methodologies to collect time-related data. In the 1960s, there was an increase in such methodological research, which moved past the economical domain. For example, in health-related studies, time-line mapping has been considered and used (Basnet et al., 2023).

Both economists and social scientists recognized some decades ago the limited interest in studying social change based on static and cross-sectional data (Davies & Dale, 1994). As an answer, new approaches were developed to 'improve our comprehension of how people choose a given alternative and reject another, and how they adjust or fail to adjust to their living circumstances' (Bernardi, 2021, p. 107). The context is therefore crucial to give meaning to social experiences (ibid.). Adaptation to environmental change entails adjustments and choices to be made within a certain context. The social sciences therefore have a lot to teach us.

Adaptation to environmental change, has been approached methodologically in multiple ways. Among these we find surveys (e.g. Bandyopadhyay et al., 2011), multilevel analysis (e.g. Reidsma et al., 2009), qualitative field case studies (e.g. Fosu-Mensah et al., 2012), spatial analysis (e.g. Watson et al., 2013), and participatory methodologies (e.g. Ross et al., 2015). Nevertheless, research on this topic and on migration as a form of adaptation in particular has been criticized for not including time (Adamson et al., 2018; Fawcett et al., 2017). To fill this gap, more recent methods have included historical and temporal approaches (Singh et al., 2019). Some of these approaches are based on the secondary review of case studies, looking at evolution and considering time as a variable (Gajjar et al., 2019). The environmental adaptation field could benefit from the application of social science methodologies. The study by Paschen and Ison (2014) is an example in this direction. These authors used narrative research to evaluate the influence of how the environment is 'storied' on future adaptation practices. They furthermore stress the need for more transdisciplinary research to open up new perspectives on this topic.

In the study of population, temporality has been included for a longer time than in the field of environmental adaptation. Within survey data, time has been included in the form of the AGEVEN record, composed of a calendar situating the major events of the respondent's life (Antoine et al., 1987) and used in the Migration and Urban Integration Survey in Burkina Faso (Enquête migration et insertion urbaine au Burkina, EMIUB). In addition, all places of residence that lasted over three months were recordedproviding a migratory history from the age of six for all respondents (Ouédraogo & Piché, 2007). Various studies used this data to link migration and environmental change (Henry et al., 2004; Hohmann, 2016). The interest in migration histories and trajectories increased the methodological diversity. Regarding migration histories, Carling (2012) developed the life history calendar or event history calendar method, where respondents and interviewers piece together the aspects of the respondent's life history. The author further identified the migration history chart, reducing the calendar to a series of lines. These methods include some sort of timeline in their process to visually report

the migratory history. Regarding migratory trajectories, methods of sequence analysis have been used to establish a typology based on the frequency, type, and age at migration (Bernard, 2022) or to identify the determinants and consequences of the trajectories (Chen et al., 2022). This approach is recent, in particular for internal migration, since there is a need for extended longitudinal microdata (Bernard, 2022). Finally, the environment-migration nexus has been enriched by a variety of disciplines, including anthropology with ethnographic studies and social sciences with the life history method or biographical approach (Singh et al., 2019). Given the growing interest in including temporality in population studies, it is to be hoped that this will push environmental adaptation studies in the same direction.

In the field of adaptation research, the introduction of a novel data collection method such as structured timeline mapping offers a complementary approach to other established methods such as the previously mentioned narrative research and event history calendar methods. While narrative research emphasizes the narrative aspect of individuals' experiences, structured timeline mapping provides a visual representation that enhances the understanding of temporal dynamics. Similarly, the event history calendar method focuses on capturing significant life events, while structured timeline mapping offers a broader view by incorporating additional contextual factors and temporal sequences. Ultimately, structured timeline mapping, along with other data collection methods, increases the richness and depth of the data collected and thereby contributes to a more comprehensive understanding of the dynamic nature of adaptation processes.

Social sciences have started to influence population studies and this article makes the bridge towards environmental adaptation studies. In parallel of how to incorporate time, authors in the social sciences have started to be interested in how human memory works and studied how to ease data collection (e.g. Friedman, 1993). By learning from these improvements, the method developed in this paper attempts to collect temporality while looking to collect trustworthy data.

b. Human memory and data collection

To collect time-related data, longitudinal data collection methods consisting of multiple measurements over time or retrospective methods can be used. However, the implementation of multiple measures is often complicated due to time constraints. For this reason, and because the timeline mapping method is retrospective involving interviews based on timelines, this paper will mainly focus on retrospective methods.

The structured timeline mapping method has been designed to collect the temporality of respondents' adaptation journeys. Their reality is collected through their words, without necessarily seeking to know the veracity – not in the sense of being a lie, but in the sense of the accuracy of their perceptions vis-à-vis reality. Adaptations are put in place as a result of what has been perceived, and it is this information that interests us. Nevertheless, to collect subjective data, i.e. data not measured by an external tool, we need to draw on human memory. This section therefore illustrates the reflection that goes into the latter, not in order to limit certain biases, but in order to facilitate the recall process and access as complete a view as possible of the respondent's lived situation (Maxwell, 2012). This embeds the method in a constructivist approach where reality is socially constructed through the subjective interpretations and interactions of individuals, recognizing that reality is multifaceted. This underscores the necessity to constant innovation in data collection methods to provide access to additional facets and to ensure that diverse viewpoints and experiences are included in the analysis (Mojtahed et al., 2014). Innovation can then come from new data collection methods, but also from improving data collection practices. A combination ensures that data collection methods evolve to increase the trustworthiness and depth of the data collected. To do this, it is necessary to think about how to access human memory. This reflection was essential in the design of the method and has not yet been addressed in this field of research. Retrospective data collections are often interested in the placement of a memory in time and an exact or relative date can be requested. To collect the most comprehensive data and access as much of the respondent's memory as possible, mechanisms have been used to facilitate participant's recall. Following Friedman (1993), three mechanisms were used. First, distance-based mechanisms that focus on events that happened more recently in time. Second, location-based mechanisms which place memories within a time span. Finally, relative times of occurrence or serial order memory that concern the sequence of events. The placement in time of an event is then made in relation to others. Conway (2001) stresses the importance of using these three mechanisms when collecting memories. To reconstruct autobiographical data, life-course trajectories, or adaptation trajectories, it is then useful to set a time span, add reference points, and start from the earliest memories.

In addition to these three mechanisms, it emerges that the combination of visual methods and interviews results in more comprehensive data while making the data extraction process less boresome to the participants (Berends, 2011; Sheridan et al., 2011). While this approach is underutilized in the environmental adaptation literature (Kolar et al., 2015), qualitative methods in human geography and in social sciences sometimes introduce a visual support to help the respondents anchor their memories in time (Kendig et al., 2014; Schoenduwe et al., 2015), such as timeline mapping (Basnet et al., 2023). However, such methods may require intensive concentration. In Schoenduwe et al. (2015), for each year, respondents had to give information on a grid about different aspects of their lives. Respondents reported the intense concentration needed, possibly reducing response depth. This study then suggests that data collection design should consider participant concentration. Prior assessment of the required data type and temporal accuracy is critical; seeking precise dates demands more concentration while relative placement to key events is an easier alternative. This paper's modified timeline mapping method gives great flexibility to the researcher according to the data he or she wants to collect since relative timing or precise dating can be asked for. Furthermore, the present data collection builds on several recall strategies to ease the process for the participants.

While most of the research focuses on the content of the timelines and less on how it influences the data collection

process, the quality of the data, or the secondary information on the understanding of social phenomena (Kolar et al., 2015), these aspects will be addressed regarding the structured timeline mapping.

3. Structured timeline mapping developed through a case study

This section will outline the structured timeline mapping method. After a description of the study area for which the methodology was developed, both the construction and implementation are covered.

a. Northern Senegal: a good case study for adaptation

This section gives some background information on the context in which and for which this method was developed. It was in this context that the method was tested before the actual data collection took place[2].

The four-year research project in which this method was developed is interested in the perception and adaptation to environmental changes in Western Africa. It furthermore builds on the literature strand that suggests the need for a broadened definition of adaptation in order to include small and incremental changes made in daily life by individuals or households to adjust to their changing environment (Castro & Sen, 2022), as well as those highlighting the need for the inclusion of temporality in adaptation research (Singh et al., 2019).

The research focused on Senegal's northern region, specifically a rural village in the Saint-Louis region, chosen for three reasons. First, the region is at the limit of the Sahel and experiences a dry climate with a four-month rainy season (Sall et al., 2011). Recurring dry spells during the rainy season pose significant challenges to crop growth or development (Salack et al., 2011), even if fertilizing or reducing crop density (Faye et al., 2018). Second, this region has been and continues to be prone to environmental changes, encompassing climatic shifts in rainfall and temperature extremes (Salack et al., 2011; Sy et al., 2022), as well as human-induced factors like dam construction (Bleibaum, 2010) and soil degradation or salinization (Diaw et al., 2015). Third, this region is among the principal ones for agricultural production and breading (ANSD, 2021). Mainly in rural areas, there is a majority of the population active in sectors highly dependent on the environmental conditions (Triplet et al., 2018). The combination of the previous points stresses the need for the population to adapt to sustain their livelihood.

Data collection in this region involved two phases to understand past household adaptations and to develop the forthcoming methodology. Phase one included informal discussions with villagers, the chief, and key informants, and testing of the methodology with approximately 15 villagers. In phase two, after modifying the initial methodology based on testing, 39 new villagers from 17 nuclear households (including 16 women) were interviewed, all of whom, including the children interviewed, were at least 18 years old. The number of interviews in each household varied, including the man and wife in seven households, the man and wife with one child in five households, and one parent with one child in five households. All households included more members but interviewees were selected based on presence and availability.

b. Construction of the structured timeline mapping method

Timeline mapping is an arts-based data collection method (Bagnoli, 2009) that uses a visual support where information about the participant can be inserted in some chronological arrangement (Kolar et al., 2015). This definition gives great liberty to the visual, the information registered, and the structure given. Inserted in the context of adaptation research and considering the well-being of participants during data collection, a specific structure was given to timeline mapping.

Timeline mapping often starts from a blank page to be filled in by the participant. Guidelines given by the researcher will help the participant know which information is looked for. Nevertheless, this can be stressful for the participant. In addition, if starting from a blank page, all timelines produced will not be on the same basis and therefore be less comparable, some being linear while others not (Kolar et al., 2015). If studies entail some sort of grouping or the identification of similarities between participants, a certain homogeneity eases the process. Therefore, structured timeline mapping adds, as its name suggests, structure to the timeline. This enables a visual basis, a timespan, and some reference points (see Figure 1).

The first step in the construction is the visual support. This visual should occupy most of the space on the support to make it as easy as possible to add information and keep things organized. In this case, an arrow is chosen for the example, but it could also be a simple line or something less linear. This choice eased the analysis but constrained the participants to a certain perspective. Other forms of timelines could shed a different light on the adaptation journey. To discuss one other possibility in contrast to the choice made in the present study,

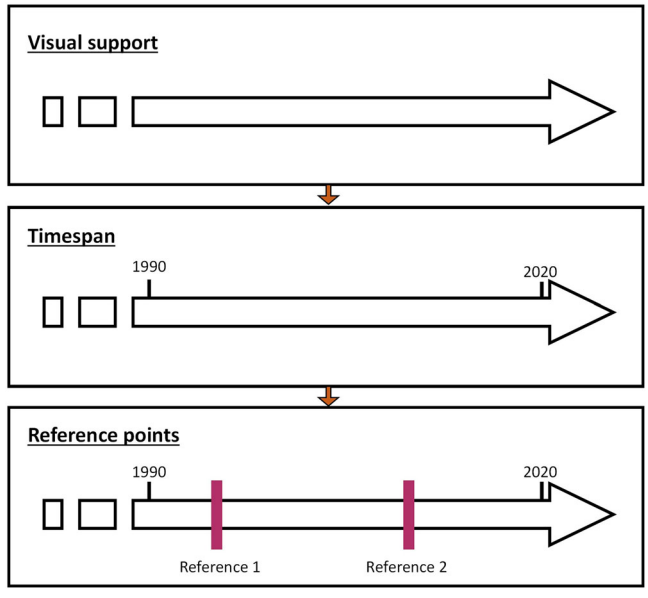

Figure 1. First steps to constructing a structured timeline.

Kolar et al. (2015) identified the continuous-line timeline in opposition to the list-like timeline used here. The continuous-line timeline results in a line moving across the space of the support where 'spikes, dips, angles, waves, and curves represent positive or negative dimensions of [the participants] experiences' (Kolar et al., 2015). Finally, all timelines offer relevant information but give a different perspective.

Second, the time span has to be defined. According to the research question(s), the time span can be more or less extensive. Nevertheless, this is important for the elaboration of the support and will give information to the participant on the precision sought. For instance, if the time span is one year, the participant is likely to give indications in terms of days. However, if several decades are looked at, the participant will be less precise and will likely give information in terms of years (see Winkielman et al., 1998). In Figure 1, only the beginning and ending of the timespan are showcased, but intermediary dates could also be added and suggest the precision of the answers looked for.

Lastly, some reference points are added. Two choices are to be made. The first choice is whether the researcher will indicate these references, someone familiar with the situation of the participants or the participants themselves. The second choice, which can influence the first, is the type of events used as a reference. On the one hand, they can be important events for the place where the participants live (e.g. the hosting of the Olympic games, the winning of the football world cup, an important political event). On the other hand, they can be important events for the participant. If this is the option chosen, at the beginning, the interviewer will ask the participant to indicate one or several reference points (e.g. a marriage, the birth of a child, the acquisition of a diploma). The overall timespan and the reference points can be interrelated; a specific event can mark the start of the period, for example, helping the participant situate the start of the period in time.

Once these choices have been made, the researcher can prepare for implementation in the field. This study gives guidance directly linked to the implementation of the timeline mapping once the area of study has been identified and the participants contacted. Different steps might be needed in different contexts, but the underlying reasoning will be detailed so it can be tailored to other situations.

c. Implementation

According to the choices made in the construction phase of the structured timelines, a preliminary phase can be necessary once on the field. For instance, if the events that serve as a reference are to be defined by an external individual, this has to be done before beforehand. This person should have a good knowledge of the situation of the participants such as the chief of the village. Even if the events are defined beforehand by the researcher based on the literature or other data sources, it is always a good idea to validate the events with a reference person. Even a subtle influence of the researcher can highly influence the way in which the participants tell their stories. Therefore, another possibility is to go on the field for the first time to define the reference events with the population through short interviews, focus groups, or informal discussions. Overall, and mainly if the research is conducted in a very different context than that of the researcher, a validation in the field of the reference points is crucial. If the events identified are not significant for the population studied, they may be disturbed by them, which may shift the focus and lead to less comprehensive data. In the present case, in addition to asking respondents about important events in their lives, two major events were identified in the preliminary field visit through discussions with the inhabitants and validated by the chief of the village as well as during the testing phase: the construction of an anti-salt dam in the 1980s, and the arrival of a food industry (SCL). A not anticipated additional advantage of this procedure was the feeling of inclusion of the chief of the village, which certainly influenced its high implication and its help during the whole duration of the data collection. The interviews confirmed the interest in these events, as illustrated by the words of this interviewee:

> There are quite a few things that have marked us, especially the dam. Before the dam, we were here; after the dam, we're still here. It's really about the interest that they have shown here; it's something that has marked us. What's more, we earn quite a bit from the water from the dam, so it's something that has a big impact on us. The SCL is also something that has come and gone here, but not for very long. It's still a company that provides a great deal of relief to the surrounding village. Because there are at least 175 to 200 fathers and mothers working there, so it's … it's part of what's already marked us. (Man, Head of household, hunting guide; translated from French)

Once the reference points are validated, data collection can start. During the process, there are different possibilities for implementing timelines. One aspect concerns the moment of completion: as a first step, during the interview, or as a synthesis. Another aspect concerns the person completing the timeline: the participant, the researcher, or both. All options present advantages and disadvantages, which lead to different information gathered and different power relations. In the data collection operated in Northern Senegal, the timeline was filled during the interview. This way, it could serve as a support during the interview, became central, and it stressed its importance to the participants. Furthermore, the researcher completed the timeline. This way, the interviewee could concentrate on the recall process and not about how to place information on the timeline. It should, however, be noted that this meant that the researcher made the choice of the information to be added to the timeline. Another more practical reason was the cross-language setting. Most participants spoke Wolof, a language not mastered by the researcher. Based on the translations by the interpreter, elements were added to the timeline. The same interpreter was present during the testing phase and the actual data collection. To evaluate the quality of the translations, the recordings were translated by a second interpreter after the testing phase (for the 15 interviews). An overlap of over 85% was observed and differences did not concern substantial information for the research. The same process was not undertaken for the actual data collection phase since the results of the evaluation were very satisfying and due to high costs in time and money.

On a more practical aspect, something that greatly helped during the fieldwork was the highly flexible support on

which the timeline was completed. Oftentimes, timelines or forms of chronology are completed on a sheet of paper. This is a rather permanent way of proceeding, i.e. once an event is written down, it is difficult to modify it. On the field, information was collected using a form of whiteboard to be able to easily erase and modify the timeline during data collection. On a big sheet of paper, the timeline was drawn with the reference points, leaving space above and under the arrow. On top, a transparent plastic film was affixed, which could be written on with whiteboard markers. Observations on the field showed that during an interview, it was common to modify events mentioned by the participants. Indeed, during the interview, new elements are continuously added, which can trigger new memories or details not recalled at first about an already shared memory.

The use of different colours provided additional information for the analysis. In this study, looking at adaptation to environmental change, if the participants mentioned a direct link between a change in the environment and an adaptation they implemented, these two elements were given the same colour (see Figure 2). A conscious link was identified when the interviewee explicitly articulated the relationship between the environment and adaptation. This was often done by describing how changes in the environment affected the household and how they responded. Not in all cases was the origin of the environmental change attributed to a specific event or structure, such as the dam or industry in our study. This gives information on whether there is a conscious link or not between adaptations and environmental changes and with events or external structures. Depending on the information sought, the colours can be used for different aspects, such as to cover different themes, different family members, or different locations.

Thus, the structured timeline mapping methodology developed here can be tailored to other situations and contexts. The two underlying principles that should guide the researcher are: (1) helping the participant in its recall process; and (2) fitting the visual to the data the researcher plans to collect.

4. Contributions of the method and discussion

The decision to include a visual aspect in the interviews, stems from a need linked to the research question. To study chronologies and evolutions in adaptations, temporality has to be central in the data collection. Based on this criterion, multiple possibilities exist, both visual and non-visual (e.g. life history calendars or history charts (Carling, 2012), life history approaches (Singh et al., 2019), livelihood history approaches (Ayeb-Karlsson et al., 2016), or cohort studies (Fawcett et al., 2017)). In parallel, some thought was given to the type of data required and its purpose. The typology that categorizes the different purposes of using visual material during interviews, developed by Glegg (2019), pushed us to choose a visual method. Two aspects of the typology were relevant here. First, it enables a different and more global representation of the data, where data can be aggregated, patterns can be mapped out, and trends can be identified. As the idea is to see how people's adaptation journey evolves, this perfectly fits the purpose. This was indeed attained and a result of the research were different types of adaptation strategies chronologies. Second, using visuals enhances data quality as it brings contextual depth and gives access to more comprehensive data (Kolar et al., 2015). This strategy was central to the design of the method: to limit the burden of the data collection process on the participants and help them recall the information sought.

a. Added value of the method: focus on temporality

In the research on climate change and environmental change adaptation, there are few studies that explicitly include

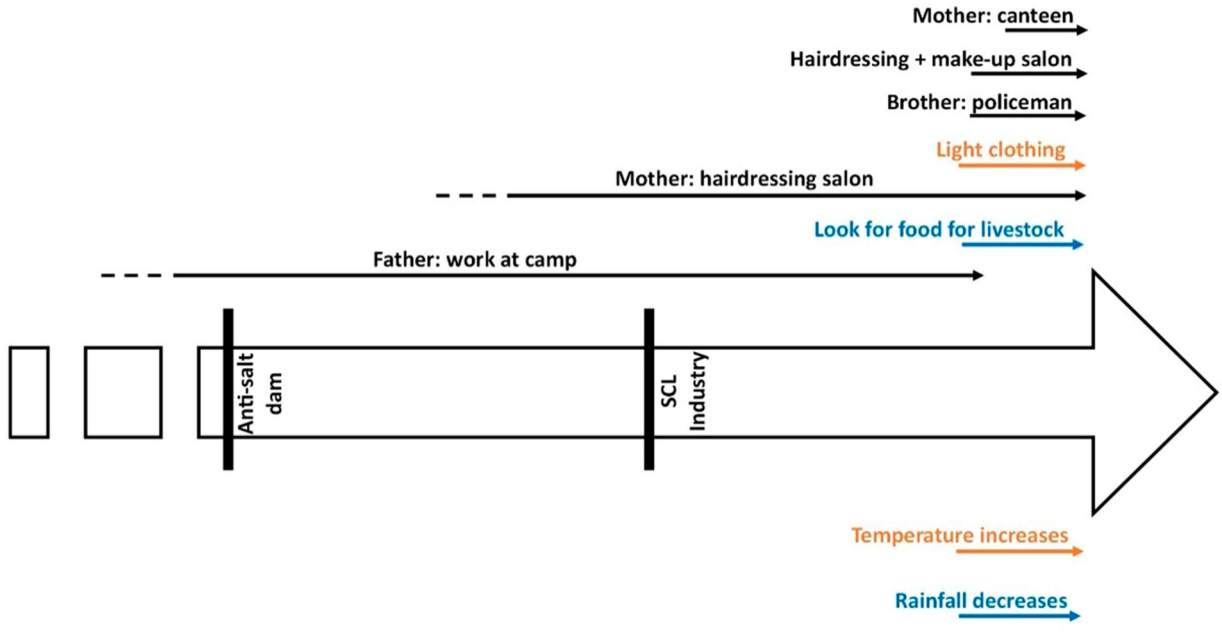

Figure 2. Example of a timeline collected during fieldwork in Northern Senegal after digitalization.

temporality, and little reflection has been made on data collection methods in that regard (Singh et al., 2019). The development of the structured timeline mapping methodology starts to fill this gap and results in different and complementary data compared to other approaches. In light of the data collection phase and the analysis performed, four aspects that make this method valuable were identified.

First, temporality is central to data collection and not a secondary tool, i.e. time is not used as a means of creating links afterwards, but as data in its own right. In this study, dating regarding the event is important, as are its duration and its relative placement according to other events, covering the past, present, and future. Indeed, the dynamics of adaptation were asked regarding the perceived changes in the environment over the last few decades. Projects of adaptation were also asked for, covering a wide period. When collecting this data from several members of the household, a very holistic view of the household is created with collective and specific actions and perceptions for each. This centrality of time is stressed by the presence of the timeline during the interview.

Second, this approach facilitates the observation of linkages and interrelations between multiple adaptations or between adaptations and perceived changes in the environment. Adaptation is a process (IPCC, 2014) embedded in a broader dynamic of interest to researchers. The data collection as carried out here enables us to dig deeper into the linkages between environmental change and adaptation processes while also giving a view on the dynamics existing between multiple adaptations. For instance, it was observed that some adaptations were linked to more than one change in the environment. In more practical terms, during the interviews, colour coding was used to illustrate the existing links (see Figure 2). These links are direct, suggesting a conscious adaptation process regarding the perceived environmental change mentioned according to the classification of Datta and Behera (2022), a link rarely explicitly studied. The structured timeline mapping gives the opportunity to make the link during the interview, and thus ensuring that the link is established by the participant and not by the researcher afterwards. This is even more crucial when the study is carried out in a context far away from the one of the researchers, in order to limit its influence on the data.

Third, the participants can also reflect on the adaptations they have implemented. In a different context of black women's experiences with severe mental illness, the importance of self-reflection is stressed as 'it does not lead to particular findings or predetermine outcomes based on the researchers' frames of reference' (Sosulski et al., 2010). In a context outside of the familiar one of the researchers, it is important to try and limit their impact on the data and the intrusion of their frames. Through the aid of the visual support, where the different aspects of interest are written down, the participants can reflect throughout the interview, making themselves linkages between several elements and adding nuance to certain aspects.

Lastly, structured timeline mapping results in a holistic or more global view of the adaptation journey of the respondents. This has, on the one hand, a benefit during the interview, as developed in the next point. On the other hand, it is beneficial for the analysis. Timelines are mainly useful to illustrate a process since, at first glance, elements pop out. For example, when looking at the timeline in Figure 2, we can immediately assess the linearity or non-linearity of the elements, the overlapping, or the relative position, just to mention a few. It is then not surprising that timeline mapping has been used mainly to study processes: pathways of treatment in substance use (Berends, 2011), trajectories and experiences of inequity for people who are homeless (Patterson et al., 2012), or journeys of weight loss (Sheridan et al., 2011). Reflecting on our data collection and in light of the four points mentioned, we stress the need to continue in this direction of using visual supports to study a process or change.

b. Importance of the timeline for the researcher and the participants

The experience on the field, in this specific cross-language setting and in a very different culture than the one of the researchers, made the timeline more useful to the researcher than to the participant. In a reflection after the data collection phase, I wrote in my field notebook:

> The timeline is a fabulous tool for me. It gives me an overview of the interview. I quickly see the gaps that need to be filled, and I can ask questions about the links between different events. However, the participants don't seem to pay much attention to it. Is this due to the language difference? Because I'm the one filling in the timeline? (Fieldnote: reflection on the data collection process, in particular the usefulness of the timeline)

Thus, the added value to the participants is rather indirect. For instance, the timeline did not directly help the respondents as they did not identify the gaps themselves, or used the visual timing of the events described. However, as the researcher could progressively add information to the timeline, the participants did not have to be chronological but could navigate freely in time as the memories came. As human memory does not always remember events in chronological order, this is a major indirect benefit to the participants. It was observed that some people started with the construction of the dam, while others concentrated at first on the last few years. The researcher could adapt to the chronology most comfortable for the participant, thereby covering a wider range of memories.

In a later stage, the use of a visual method enhanced the communication of the results and analysis with the participants, thus promoting knowledge sharing and potential participation in future adaptation strategies (Bagnoli, 2009).

c. Trustworthiness of data collected through structured timeline mapping

To conclude this section, a final point is made to bring some reflexivity on the data collection process. During the developmental phase of the method, extended reflection was made around how to collect complete data. After the data collection phase some form of evaluation of the quality of the data was looked for through triangulation as the use of timeline mapping is new in the field of adaptation research. Triangulation was used for this purpose, not with the goal of establishing factual veracity, but to enrich the depth of understanding of the

phenomenon under study, consistent with Denzin and Lincoln's (2011) explanation of triangulation as the pursuit of in-depth understanding. In our study at least two independent interviews were conducted within each household, enabling data source triangulation (Carter et al., 2014) and the crossing of multiple realities with one another. This way, researchers can uncover patters, contradictions, and nuances that contribute to a richer understanding of the phenomenon studied. Furthermore, it encourages reflexivity, prompting researchers to critically examine their assumptions, biases, and interpretations throughout the research process. In addition to this triangulation of data, a workshop was conducted about a year after data collection with the idea of both restitution and validation of our analysis. For this purpose, a meeting was organized by the village chief in the village where the data collection took place (Mondain et al., 2012). In an attempt to free the exchange of ideas and open a space for questioning, small discussion groups were formed without the presence of the researcher, after which the main observations were reported. Both processes confirmed corroborations and that participants related well to the results, while adding precision on certain aspects, being surprised by some, and insisting on others. Ultimately, these methods were considered sufficient to explore how individual subjectivities intersect and contribute to the creation of a transitional space that allows social actors to recognize themselves in the research findings (Denzin & Lincoln, 2011).

Finally, transparency and awareness are essential to limit the impact of power dynamics on the quality of data collected and analysis (Anyan, 2013). The study interviewed at least two members of the same household, usually including the head. To mitigate the influence of power, interviews were a person of the opposite sex was present were excluded from the final analysis, in line with Boeije (2004). In addition to theoretical support, field experience also supports this idea. One interview in particular suggested the negative influence of the presence of a spouse. In this interview, the husband was present for the first half of the interview, after which he left and the flow of the interview improved significantly. Therefore, it seems reasonable to exclude interviews in which another male member of the household was present. The opposite case, the presence of a woman during an interview with a man, did not occur. The presence of the interpreter, who happened to be male, could be a potential concern. However, he has weak ties to the individuals as he does not come from the same village or from neighbouring villages and therefore does not have the same influence on the data collection process (see Granovetter, 1973). The exclusion concerned five interviews. In the event of disagreement in the storytelling among members of the same household, priority was given to information from the most affected person. Informed consent was obtained consistently, emphasizing participant rights to reduce researcher dominance. Interviewee comfort was prioritized by discussing the time and place of the interview.

5. Conclusion

This article developed a complementary approach to data collection to explore temporality in the analysis of environmental adaptations. This field of study has received increasing attention in recent years, but only few studies have included temporality. The structured timeline mapping methodology outlined comes to complement previous efforts to elaborate original data collection methods with the objective of offering a new perspective on the matter. However, in terms of future use and development, a reflection on how this tool can be transferred and used by the community to make it a valuable support for everyday adaptation strategies would be highly welcome. Action research is one way of moving in this direction, and we're thinking in particular of the Adaptation Research for Impact Principles as a good way forward (Gajjar et al., 2021).

The data collected through this method, applied to the case of Northern Senegal, gives information on the temporality of the adaptations (duration and position in time), as well as on the interrelationships between the different elements displayed, while giving the participants space to self-reflect on their situation. Finally, this method results in a global and visual view of the adaptation journey of the participants. Concerning the analysis, the data can be aggregated, patterns can be mapped out, and trends can be identified, leading to a better understanding of the adaptation journeys. The dynamic process of adaptation can thus be explored and complement previous methods that focused on a more static view. It is by combining both approaches that a better and more global comprehension can be attained, that is to say a better global comprehension of the societal context with a greater awareness of the interconnectedness between environmental changes, internal household dynamics, and adaptation strategies in order to make more informed decisions.

This method is inscribed in social sciences, and further efforts have to be made in the field of environmental adaptation to do multidisciplinary research in order to enhance our field of research.

Notes

1. Panel data are an exception in that it involves multiple observations over time. Multiple examples of research using this approach to study migration exist (see for example, Massey et al., 2010). Nevertheless, this approach is very costly, especially in terms of time. In addition, as will be developed in this article, the structured timeline mapping methodology is inscribed in retrospective data collection and based on a visual. This offers many advantages and results in different data, hence its interest.
2. The University of Namur's ethics committee has been consulted about the steps to be taken to ensure the protection of interviewees. No personal data allowing identification of the individual was collected, and if this was given spontaneously, the recordings and transcriptions were anonymized. In this context, by guaranteeing the anonymity of the participants, no further steps were necessary. Nevertheless, oral consent was asked and all necessary information about the research and the rights of the participants was communicated before starting the interviews.

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