



## Research

# Sustainable futures: from causes of environmental degradation to solutions

Carla Sofia Ferreira Fernandes<sup>1,2</sup>  · Fátima Alves<sup>1,2,3,4</sup>  · João Loureiro<sup>2</sup> 

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## Abstract

The impacts of climate change, loss of biodiversity and pollution influence the living experiences of the various members of communities that rely on agriculture, shaping the adaptation responses to those phenomena and actions towards sustainable development. This study aims to understand how members of rural communities in Morocco perceive the causes of environmental degradation and the solutions meant to support the reduction of the vulnerabilities by applying a sustainable development lens. To achieve those objectives, this empirical study collects qualitative data by conducting semi-structured interviews on the local population's perceptions of environmental degradation causes and impacts, vulnerabilities, and solutions to adapt or cope with those impacts. The study includes a critical analysis of the proposals presented by the community members by addressing the economic, social, and environmental dimensions of their implications for development. The most common issue identified was water management, underscoring the water stress affecting several regions. However, several solutions presented would lead to further depletion of non-renewable water sources, which endangers the pursuit of genuinely sustainable development. The study's conclusions highlight the importance of contextualising the communication and adaptation responses that address local perceptions, namely the low prevalence of perceptions attributing anthropogenic causes to environmental degradation, leading to sentiments of helplessness among members of the rural communities.

**Keywords** Environmental degradation · Social perceptions · Sustainable development · Morocco

## 1 Introduction

The consensus of scientific research on climate change and planetary challenges regarding biodiversity loss and pollution must be accompanied by governance and societal and political mobilisation that leads humanity into sustainable pathways [1]. Environmental degradation is a process affecting the general health of the environment that contributes to reducing its biological diversity, which can be further accelerated by human activities [2]. Among the latter, the Intergovernmental Panel for Climate Change [3] highlights the growing anthropogenic emissions of greenhouse gases responsible for climate change impacts, such as increases in average temperature, sea level rise, increases in the frequency and intensity of climate and weather extremes, including droughts, and changes in global precipitation patterns [4].

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✉ Carla Sofia Ferreira Fernandes, 1600737@estudante.uab.pt | <sup>1</sup>Universidade Aberta, 1269-001 Lisbon, Portugal. <sup>2</sup>Centre for Functional Ecology-Science for People & the Planet, Department of Life Sciences, Faculty of Sciences and Technology, TERRA Laboratory, University of Coimbra, 3000-456 Coimbra, Portugal. <sup>3</sup>Observatory of Sustainable and Healthy Territories of Bocaina, Rio de Janeiro, Brazil. <sup>4</sup>Sergio Arouca National School of Public Health (Ensp), Oswaldo Cruz Foundation (Fiocruz), Rio de Janeiro, Brazil.



Environmental degradation has been progressively affecting terrestrial, marine and freshwater ecosystems and, consequently, the services provided to human life, reducing the quality of life. In parallel, lower socioeconomic conditions might entail more substantial pressure on degrading natural systems without accompanying investments in natural capital, culminating in a vicious circle of environmental degradation and poverty [1]. In Morocco, water scarcity and droughts are often identified as the most crucial dimensions of environmental degradation by the population from rural areas [44] and official institutions [45]. Water scarcity intensifies mainly from diminishing surface water and increasing demographic and economic development pressures [45]. Solutions that aim to improve the overall conditions must consider the different manifestations of environmental degradation as they are expected to be more intense.

According to the 2030 Agenda of the United Nations, sustainable development ensures a balance between the economic, social, and environmental dimensions [5]. It requires an approach that explicitly protects the environment from further degradation to support the needs of the present and future generations. Environmental degradation affects the existing development pathways globally; for example, the IPCC claims with high confidence that climate change limits the options and opportunities for sustainable development [4]. Adapting to a changing environment and climate requires responses that address what makes the different communities vulnerable to their effects [6]. The increasing degradation of the environment, particularly the aggravated impacts of climate change, is already shaping the experiences and knowledge of individuals, thus contributing to the framing of their responses. Analysing this experience and expertise provides a foundation for a better understanding of what could constitute inclusive and effective adaptation measures [7].

Nevertheless, since individuals might perceive antagonisms between social, environmental, and economic sustainability [8], those measures might only be partially sustainable as they might privilege or address only one or two pillars of sustainable development. However, there are claims that the actual Sustainable Development Goals (SDGs) agreed on in the 2030 Agenda for Sustainable Development are in themselves favouring different pillars, which leads to the conclusion that there are goals potentially contradictory, with some goals focusing on creating harmony with nature, while others require an economic growth of 3%, which endangers the feasibility of achieving truly environmentally sustainable development [9]. Therefore, it is necessary to improve the understanding of sustainable development and achieve truly transformative solutions, which requires expanding the focus to include all aspects of socioecological projects, not only their material outcomes [10]. The solutions must also include all the stakeholders at all project stages, from conceptualisation to implementation and subsequent evaluations [6]. Those solutions should limit possible tendencies to implement technical methods in a top-down approach from external experts without integrating the people they are supposed to support to reduce their vulnerabilities [11].

In Morocco, the National Strategy for Sustainable Development identifies seven main areas of intervention in their development pathways, namely governance of sustainable development, transition towards a green economy, improvement of the management and the enhanced value of natural resources and strengthening of the biodiversity conservation, acceleration of the implementation of the Climate Change Policy, special considerations regarding the sensitive territories, promotion of human development and reduction of social and territorial inequalities, and promotion of a culture of sustainable development [12]. The transition towards a green economy has provided steady socio-economic growth. However, the reliance on fossil fuels for energy needs has also meant that the environmental costs are also getting higher, which should lead to a rethinking of the development pathways being undertaken [13]. Other priorities, such as biodiversity conservation, still need to be fully achieved due to the prevalence of agricultural practices favouring monocultures, which is a significant driver of biodiversity loss [14]. These examples suggest that the development pathways still allow space for improvement, and more changes are required to achieve what is enshrined in Article 31 of the Moroccan Constitution of 2011: "Sustainable development is a right of every citizen" [12].

Morocco is the most sensitive to climate change impacts among the five North African countries due to agriculture's relative importance in the economy and employment opportunities [15]. In Morocco, agricultural productivity is strongly linked to precipitation, which has been negatively impacted by climate change through its exacerbation of situations of water deficiency [16]. Several regions in Morocco are very vulnerable to water stress, meaning they have a limited capacity to cope and respond to climate variability and extreme phenomena [17]. Therefore, in Morocco, reducing the dependence on rain-fed agriculture and increasing the adaptive capacity is essential [15]. One of the solutions implemented to improve water management consisted of changing the existing community management for a participatory approach; however, for some areas, even though it improved the agricultural output, it has further depleted the available water reserves [18]. The maximisation of the farming output is often the main objective of policies, and it is necessary to shift to more integrated solutions that address environmental and social perspectives, not only economic ones [19].

It is essential to integrate the local pluralities of knowledge in scientific research and understand how climate change and environmental degradation are perceived and what actions are being actively deployed in different contexts [20].

With this study, the authors aim to expand the knowledge that focuses on understanding how the population experiences climate change and environmental degradation impacts and how they imagine the future regarding the impacts and possible solutions. To achieve this understanding, this study focuses on members of rural communities in Morocco. It gathers information on the social perceptions of the causes of environmental degradation, the prospects of their impacts, and what solutions are identified to support the reduction of the vulnerabilities identified from a sustainable development perspective.

## 2 Methods

This study is one part of a multistage research project that focuses on the social perceptions of the impacts of environmental degradation and subsequent adaptation responses in agricultural communities in Morocco. This case study provides an overview of the social perceptions of the causes of environmental degradation by including open-ended questions that aimed to understand what our interviewees saw as the environmental components impacted by degradation and the factors that they believe led to the current situation. It gathers information on the prospects of the evolution of those phenomena and what solutions they envision. This local understanding is achieved by focusing on individual perceptions since it is that knowledge that informs the actions of individuals [21]. By centring the narrative on the individual and their projections of adaptation to a degrading environment and changing climate, it is possible to inform policies that specifically address the vulnerabilities [48].

While in an exploratory stage, we have conducted interviews with policymakers to understand the context better; this empirical study focuses specifically on collecting and analysing the data obtained by conducting 34 semi-structured interviews between October 2022 and January 2023 with members of rural communities who continue working in agricultural-related occupations or have migrated to urban areas. The links, past and present, to the agricultural sector were essential in selecting the interviewees since it is a sector particularly affected by climate and environmental-related phenomena.

Regarding the participants who had migrated from rural areas and no longer have activities directly related to agriculture, the participants were identified using the snowball technique [22]. The participants who are still actively engaged in agricultural activities were identified by a local association member supporting rural communities in Souss-Massa. Due to the explorative qualitative nature of the study, statistical representativeness is not a priority, and the focus is instead on collecting a wide variety of responses that address the research topics. The data collection stops when the information reaches a saturation level, meaning no new information is being added to the existing responses [23].

The interviews occurred in the presence of a linguistic and cultural mediator, which supported the translation and the cultural contextual framing of the questions and responses due to the different origins of the researchers and participants in this study. Several linguistic and cultural mediators were selected for the interviews due to their knowledge and academic background, which were suitable for providing a link. The linguistic translation during the interview and the support in the interpretation during and after the interview were essential to frame the responses in their context [47]. The initial step of the interview consisted of informing the participants of the research objectives, collecting informed consent to record the sound of the interviews, and using the contents. All participants were guaranteed informed consent, confidentiality, and anonymity. No minors were included in the study, and no sensitive information was collected. Participants were informed that they could interrupt the interview at their wish.

The interviews covered different topics in the multistage research project. For this particular study, three sections of the interviews were considered in detail: the first section focuses on social perceptions of the causes of climate change and environmental degradation, the second on the social perceptions of the prospects of environmental degradation, and the third on collecting proposals and suggestions for action centred on supporting the communities in adapting to a changing environment and climate, while also approaching issues related to mitigation.

The audio of the interviews was later transcribed and further translated into French, when necessary, with the support of the linguistic and cultural mediators. The qualitative analysis of the transcripts was supported by MAXQDA, which required that all transcripts be uploaded into the software and that the coding of categories be inductively created to mirror the diversity of responses in all the interviews [46], starting with the classification of the answers according to the three sections presented in the previous paragraph. After the cycles of categorisation and coding were finalised, the selected categories were systematically analysed to address the research objectives.

### 3 Results

This study aims to understand how the population experiences climate change and environmental degradation impacts and how they imagine the future impacts and possible solutions. This section summarises the findings of the qualitative data collection regarding social perceptions of the causes of environmental degradation (Sect. 3.1), prospects of environmental degradation impacts (Sect. 3.2) and proposals from the community (Sect. 3.3) to address the issues stated in the two first sections.

#### 3.1 Causes of environmental degradation

The results showed that the most frequent responses to inquiries about the causes of the perceived environmental and climate changes were reluctance to reply and lack of knowledge. The second most common response referred to transcendental factors as significant contributors to environmental degradation. This perspective seems to be influenced by the role of religion in shaping their thoughts and actions. Causes attributed to Divine intervention were more frequently identified as drivers of environmental degradation: “May God give us rain, and have mercy on us” (male, 60, farmer from Drâa-Tafilalet in Souss-Massa).

“The land has become more difficult for farming. When there is rain, there is more production. (...) Rain is a blessing from God, and it changes everything; it brings the land back to life. (...) Rain has become weaker. (...) God gives food to people. (...) If there is no agriculture, there is nothing” (male, 66, farmer from Drâa-Tafilalet in Souss-Massa).

Some participants in our study also suggested that environmental degradation results from natural processes. They believe these environmental changes are inherent aspects of natural cycles or processes. While this view was not widespread among our participants, it offers a contrasting understanding of environmental degradation and reflects the variety of opinions on the causes of environmental degradation:

- “This change comes from nature. It’s not only here... it is everywhere in the world” (male, 43, worker in gas station in Casablanca from Drâa-Tafilalet);
- “It comes from God or nature” (male, 56, security guard in Casablanca from Drâa-Tafilalet).

Finally, and in addition to the previous views of lack of knowledge regarding the causes or attributing them to divine and natural forces, less than half of the respondents identified anthropogenic causes for the perceived changes in the environment, namely pollution, industrial activities, use of fossil fuels and deforestation:

- “Factories, too many factories, too many cars. Those are the causes. A lot of pollution” (male, 36, worker in a gas station, migrant from Drâa-Tafilalet in Casablanca);
- “People cut down the trees to clear land for farming” (female, 42, daily worker in agriculture, migrant from Marrakech-Safi in Souss-Massa).

#### 3.2 Prospects of environmental degradation impacts

The second part of the interview aimed to collect the population’s perceptions regarding what they believe to be prospective evolutions of the impacts of environmental degradation since the decision-making process on an individual/household level on how to adapt relies on the individual perceptions of future developments. The respondents, when questioned about their expectations for the future, most frequently suggest optimism and hope and anticipate an enhancement in the local circumstances and a shift in the status quo:

- “The rain will fall” (male, 54, security guard in Casablanca from Souss-Massa);
- “I see it [the future] as something positive. Right now, things are better than before. Every time I go back, I see something new. Before, it was nothing more than a desert” (male, 38, driver in Casablanca from Souss-Massa).

As per the responses to the causes of environmental degradation and climate change, the participants frequently invoke Divine references when discussing potential futures. The participants regularly allude to a Higher Power while conversing about expectations for what lies ahead:

- “What can I say [about the future]? We hope God will make things better. Only God knows” (male, 41, farmer, Souss-Massa);
- “God is the one responsible for the future. God knows the future, and we cannot predict anything. And God only does what is good, but people need to work, that’s all!” (male, 66, farmer in Souss-Massa from Drâa-Tafilalet).

A pessimistic outlook towards the future emerges as a less common yet significant theme in the responses:

- “[The future] Depends on the climate. And it is getting worse. We say it will change and that everything is the will of God, but in reality, we are afraid for our future. Even if you have a suitcase full of money, if you don’t have a glass of water, you have nothing” (female, 42, daily worker in agriculture in Souss-Massa from Marrakech-Safi).
- “There is no future there [in Drâa-Tafilalet]. People are only looking for a better life” (male, 45, gardener in Casablanca from Drâa-Tafilalet);
- “It [the future] depends on the resources: if people have the resources, they can do a lot of things; if not, they will suffer” (male, 70, salesperson of agricultural tools in Souss-Massa from Marrakech-Safi).

### 3.3 Proposals from the community

The third and final section of our semi-structured interviews sought to gather information on proposals supporting the response to ongoing environmental degradation. The predominant sentiment among participants is a sense of helplessness, with many believing in the lack of viable human intervention to aid the adaptation. Underlying the narratives, there is a perceived limitation to human intervention regarding adaptation or mitigation. This encapsulates the feeling of powerlessness and the prevalent belief among participants that human actions might not be capable of effectively supporting adaptation to environmental degradation. It highlights the gap between the perceived severity of environmental problems and the perceived ability to influence change, as the lack of water is understood as a fatality, and only Divine intervention can help:

- “If there is no water, there is nothing we can do” (male, 30, driver in Casablanca from Souss-Massa);
- “Only rain could help” (male, 42, worker in gas station in Casablanca from Drâa-Tafilalet);
- “There is nothing they [authorities] can do, all comes from God” (male, 70, salesperson of agricultural tools in Souss-Massa from Marrakech-Safi).

Nearly half of the participants defended systems of management of water resources, which constituted the most frequent proposal for adaptation:

- “I think people should drill more boreholes” (male, 49, daily worker in agriculture in Souss-Massa);
- “We have to save water by using dams or water conservation structures” (male, 59, driver in Casablanca from Fès-Meknès).

Water efficiency measures were also indicated, such as “drip irrigation [in farming]” (male, 56, security guard in Casablanca from Drâa-Tafilalet) and forbidding farming certain agricultural products that require water-intensive farming, such as watermelons:

- “Each region has its specific conditions so the authorities must implement measures in line with the characteristics of each region, for example, they have forbidden the production of watermelon, oranges, and avocados in certain areas of Souss-Massa. However, these measures are not very effective because when you stop people from doing something in one place, they move to another place to do the same thing” (male, 45, agronomic engineer, Souss-Massa).

Regarding agriculture, several respondents touched on issues related to agricultural practices that are not explicitly related to water by presenting solutions that could support the adaptation to an environment marked by progressive degradation:

- “People need to stop overexploiting [the soils] and farm everything natural. Biodiversity is important. In the oases of Souss-Massa, some trees have survived drought cycles due to biodiversity, which allowed the continuity of agricultural activities. (...) I plan to move to an area where there is still biodiversity; that’s where the future is” (male, 45, agronomic engineer, Souss-Massa).

Other proposals that seek to improve the living conditions of the population in rural areas by supporting adaptation to a changing environment included diversifying job opportunities and improving access to education, health, and financial accessibility:

- “Currently, there are only opportunities in agriculture and construction work. Availability of employment is important” (male, 42, gardener in Casablanca from Souss-Massa);
- “Just work for people and a fair income for families” (male, 39, farmer, Souss-Massa);
- “The associations and the cooperatives must intervene (...) to create job opportunities. People need to have an occupation. (...) Now there are a lot of things that are being done by the associations and the cooperatives. (...) It is necessary to support the associations, the cooperatives, mainly the cooperatives, the State needs to do that” (male, 52, concierge in Casablanca from Souss-Massa).
- “Everything related to education is very important for people to face climate change” (male, 28, nurse in Casablanca from Souss-Massa);
- “Education, health, creating [financial] funds” (male, 57, farmer, Souss-Massa).

Nearly one-third of the participants mentioned initiatives that address issues of mitigating environmental degradation, such as reducing waste, controlling pollution from industrial activities and transportation, as well as shifting toward renewable energy:

- “They must reduce wasting water, the number of factories, and landfills in nature. It is necessary to treat garbage to make it useful... reducing the number of cars” (female, 42, daily worker in agriculture in Souss-Massa from Marrakech-Safi);
- “It is a global problem. Even if we do something here, others will pollute... maybe for our environment here, we can use clean energy in agriculture...” (male, 57, farmer, Souss-Massa);
- “Maybe in the future, electric vehicles can contribute to improving the situation” (male, 41, farmer, Souss-Massa).

## 4 Discussion

One of the results of the analysis of the interviews is related to the prevalence of divine causes in the attribution to the changing climate and a reliance on a Higher Power for future developments in the climate and environment. Besides revealing a solid level of religiosity, it directly impacts how policymakers communicate climate and environmental changes since, if not considered, it might lead to a mismatch between the policies and the general perceptions of environmental and climate change [24]. The reflections from several participants suggest that the cause of the perceived environmental degradation is a reaction from God to human behaviour: “It is the presence of injustices that leads to less rain. People are not attached to the religion; they are not attached to Islam, which leads to less rain and a climate that is less beneficial for people (male, 28, nurse in Casablanca from Souss-Massa). This perspective is not entirely in line with the views presented at the International Islamic Climate Change Symposium in 2015 that presented environmental degradation not as a punishment but as a consequence of the non-respect of the moral obligation to reduce pollution and care for the Planet [25]. It is possible to use religious texts to frame the general communication on environmental degradation by making it a moral imperative [26], but this is not being applied in Morocco.

Regarding mitigation efforts, institutionally, Morocco is recognised as among the top 10 countries deploying the most efforts towards climate mitigation: reducing its greenhouse gas emissions and adopting renewable energy, despite the meagre rate of its share of renewable energy [27]. Though not statistically representative of the country, the results of

this study indicate that the population might not fully understand mitigation policies concerning climate change due to a lack of attribution of anthropogenic causes. A general cross-country study conducted by the International Monetary Fund, which does not include Morocco, indicates that the knowledge and, therefore, the perception of the importance of climate change mitigation policies is very heterogeneous and underlines the need for effective communication to raise awareness of climate change mitigation policies [28].

One specific concern was the exaggerated use of private cars, with one participant suggesting, for example, that private vehicles should have limitations regarding circulation during the night to reduce pollution levels (in the city of Casablanca), while several participants suggested support for electric vehicles. There are still various challenges in using electric cars in Morocco [35], and the benefits of electric vehicles in terms of greenhouse gas emissions mitigation are more relevant when there is a low-carbon electricity mix [3]. In Morocco, renewable sources of electricity, namely wind and solar, represented 17.1% of the total mix of electricity generation in 2021 [36]. A sustainable transport system would require fully decarbonising those vehicles' energy and production processes [37].

Water management is the most mentioned concern in the areas of intervention, with nearly half of the participants pointing it as a priority in terms of adaptation to the changing environment and climate. One of the actions proposed consisted of limiting the production of certain items that require water-intensive farming practices, namely watermelon and avocado. In practice, large agribusinesses invest in areas in Morocco with abundant water and a favourable business environment, overexploit the resources, and then move to another place when the conditions are no longer favourable [29].

Regarding water management, several participants also suggested digging more boreholes and building dams to increase access to water. Regarding dams, the principal irrigation source in Morocco [30], the 6th Assessment Report from the IPCC forecasts a further reduction in surface water availability and indicates that dams disrupt existing ecosystems. Therefore, its sustainability is not guaranteed [4]. The impact of climate change on surface water availability and increased demand for water, in general, has placed additional consumption pressures on groundwater resources, which have also been affected by increased salinisation and soil contamination with nitrates used in farming [31].

Another proposal in terms of water management consisted of improving efficiency, for example, by using drip irrigation. However, this widely policy-supported technique in Morocco, precisely, and in the North of Africa in general, is not leading to more water savings than more traditional forms of irrigation, namely flooding. This inefficiency is partially related to the farmers' incorrect use of the technique and the fact that more areas are now being farmed since it is easier to provide irrigation by moving water tanks for drip irrigation [30]. These issues raise new concerns regarding reaching sustainable uses of water and offer new courses of action, such as improving farmers' training on the actual application of drip irrigation techniques. However, the interaction between society, environment and technological innovation is complex. Therefore, it is necessary to avoid simplifications regarding the application of technology to improve the adaptation (and mitigation) capacity [32]. In that sense, when a technological solution does not provide the expected results, it is necessary to understand how it is applied in detail. Technological solutions are constantly evolving, and they need to be integrated with the social, economic, and political factors to exploit their potential for achieving sustainable development [33]. The proposals also addressed the emissions of greenhouse gases and pollutants in farming activities, e.g., by using solar energy for water pumping. Sea water desalination and wastewater treatment might reduce the burden on existing water resources [31]. However, there are concerns about the energy required to implement these solutions [19, 34].

One of the proposals for supporting the communities in mitigating environmental degradation and climate change consisted of protecting the environment by encouraging biodiversity in agriculture, increasing organic farming, and avoiding overexploitation of soils. Biodiversity in farming practices also contributes to more stable levels of yields while also providing higher levels of ecosystem services to the farmers, e.g., due to the possibility of obtaining more varied products [38]. Regarding the importance of organic farming, some interviewees identified the use of too many chemicals in food production as one of the current detrimental changes in our overall environment: "Before the [agricultural] production was good, but not now. (...) Now there is quantity but not quality. (...) Before everything was organic, and now (...) now there are a lot of chemicals" (female, 42, cleaner in Casablanca from Béni Mellal-Khénifra). One participant indicates that in the future, he intends "to stop using hybrid seeds and favour local varieties. I will not produce a lot but instead will focus on quality. No chemical products, only natural products with lower costs but reasonable yields (male, 45, agronomic engineer, Souss-Massa). Organic farming in Morocco is still in the initial stages. However, it is a promising transition towards sustainable agriculture in the Moroccan context [39]. To advance in this transition, Moroccan institutions must support farmers and coordinate among all the actors in the agricultural sector to reduce water consumption and excessive use of chemicals (fertilisers and pesticides) and to improve biodiversity [40].

Creating job opportunities in areas other than agriculture is considered necessary to support the population in adapting to environmental degradation, mainly through the support of the Social and Solidarity Economy (SSE), namely associations and cooperatives. The SSE are vital for inclusive social and economic development [41]. Morocco's National Strategy for SSE has the ambition that this sector will contribute to nearly 9% of the employment opportunities by 2030, according to the official information published by the Ministry of Tourism, Artisanry and Social and Solidarity Economy [42]. While the national ambitions are supported by a legal framework and specific targets in terms of contribution to the economy and creation of job opportunities, the core of this sector in Morocco remains anchored on its contribution to society and culture and, therefore, its importance is plural and so is its contribution to sustainable development [43].

## 5 Conclusion

Environmental degradation is acknowledged by people with links to agriculture in Morocco as already affecting livelihoods. However, the causes are often not associated with human activity; instead, the divine is frequently suggested to be the main driving force behind the negative changes. This way of framing the direct attribution for the changes needs to be taken into consideration when deciding on communication strategies of policies for addressing mitigation measures related to environmental degradation, including climate change and as part of the area of intervention, "promotion of a culture of sustainable development" in the National Strategy for Sustainable Development.

This study highlights the perceptions of members of rural communities regarding priorities of intervention in the context of environmental degradation, with the highest priority being accorded to water management interventions. The agricultural communities feel that several regions in Morocco face the current water stress situation. However, the solutions proposed might not always be aligned with sustainable development in general; for example, the suggestion of increasing the exploitation of groundwater resources to meet existing water demand and address the economic development pressures might not be in line with the sustainable management of water resources, by not guaranteeing the access to water resources for future generations.

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**Data availability** The authors' data supporting this study's findings are available upon reasonable request.

**Code availability** Not applicable.

## Declarations

**Ethics approval and consent to participate** This research received approval from the Scientific Council of Universidade Aberta, adhering to ethical protocols outlined in national and European codes, specifically following the guidelines of the Helsinki Declaration. The study implemented informed consent procedures and ensured anonymity throughout.

**Competing interests** The authors declare no competing interests.

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## References

1. Folke C, Polasky S, Rockström J, Galaz V, Westley F, Lamont M, Scheffer M, Österblom H, Carpenter SR, Chapin FS, Seto KC, Weber EU, Crona BI, Daily GC, Dasgupta P, Gaffney O, Gordon LJ, Hoff H, Levin SA, Walker BH. Our future in the Anthropocene biosphere. *Ambio*. 2021;50(4):834–69. <https://doi.org/10.1007/s13280-021-01544-8>.
2. Environmental degradation. <https://www.eionet.europa.eu/gemet/en/concept/15154>. Accessed 4 Aug 2023.
3. IPCC, Shukla PR, Skea J, Slade R, Al Khourdajie A, van Diemen R, McCollum D, Pathak M, Some S, Vyas P, Fradera R, Belkacemi M, Hasija A, Lisboa G, Luz S, Malley J. Climate change 2022: mitigation of climate change. Contribution of working group III to the sixth assessment report of the intergovernmental panel on climate change. Cambridge, New York: Cambridge University Press; 2022. <https://doi.org/10.1017/9781009157926>.
4. IPCC, Pörtner H-O, Roberts DC, Tignor M, Poloczanska ES, Mintenbeck K, Alegría A, Craig M, Langsdorf S, Löschke S, Möller V, Okem A, Rama B. Climate change 2022 impacts, adaptation and vulnerability. Contribution of working group II to the sixth assessment report of the intergovernmental panel on climate change. Cambridge, New York: Cambridge University Press; 2023. p. 3056.
5. UN (United Nations). Transforming our world: the 2030 agenda for sustainable development. A/RES/70/1. 2015
6. Schipper ELF. Catching maladaptation before it happens. *Nat Climate Change*. 2022. <https://doi.org/10.1038/s41558-022-01409-2>.
7. Burke BJ, Welch-Devine M, Sourdriil A. Understanding Microexperiences of climate change: how climate ethnography informs collaboration, adaptation, and effective responses. In: Welch-Devine M, Sourdriil A, Burke BJ, editors. *Changing climate, changing worlds: local knowledge and the challenges of social and ecological change*. New York: Springer International Publishing; 2020. p. 1–13.
8. Bain PG, Kroonenberg PM, Johansson L-O, Milfont TL, Crimston CR, Kurz T, Bushina E, Calligaro C, Demarque C, Guan Y, Park J. Public views of the sustainable development goals across countries. *Nat Sustain*. 2019. <https://doi.org/10.1038/s41893-019-0365-4>.
9. Hickel J. The contradiction of the sustainable development goals: growth versus ecology on a finite planet. *Sustain Dev*. 2019;27(5):873–84. <https://doi.org/10.1002/sd.1947>.
10. Carr ER. Properties and projects: reconciling resilience and transformation for adaptation and development. *World Dev*. 2019;122:70–84. <https://doi.org/10.1016/j.worlddev.2019.05.011>.
11. Taylor M, Eriksen S, Vincent K, Brooks N, Scoville-Simonds M, Schipper L. Putting “vulnerable groups” at the centre of adaptation interventions by promoting transformative adaptation as a learning process [Report]. Ås: Norwegian University of Life Sciences; 2022.
12. Royaume du Maroc. Stratégie Nationale de Développement Durable 2030—Rapport Final. 2017.
13. Houssini K, Geng Y. Measuring Morocco’s green growth performance. *Environ Sci Pollut Res*. 2022;29(1):1144–54. <https://doi.org/10.1007/s11356-021-15698-1>.
14. Dahan R, Moussadek R. Ecosystem services to promote Conservation Agriculture practices in Morocco: Challenges and opportunities. 2023. <https://repo.mel.cgiar.org/handle/20.500.11766/68007>
15. Schilling J, Hertig E, Trambly Y, Scheffran J. Climate change vulnerability, water resources and social implications in North Africa. *Reg Environ Change*. 2020;20(1):15. <https://doi.org/10.1007/s10113-020-01597-7>.
16. Belcaid K, Ghini A. Measuring the weather variability effects on the agricultural sector in morocco. In: Xu J, Ahmed SE, Cooke FL, Duca G, editors. *Proceedings of the thirteenth international conference on management science and engineering management*. New York: Springer International Publishing; 2020.
17. Mansir I, Bouchaou L, Chebli B, Ait Brahim Y, Choukr-Allah R. A specific indicator approach for the assessment of water resource vulnerability in arid areas: the case of the Souss-Massa Region (Morocco). *Hydrol Sci J*. 2021;66(7):1151–68. <https://doi.org/10.1080/02626667.2021.1924379>.
18. Azemzi H, Erraoui EH. Irrigation water management and collective action: understanding the shift from community management to participatory management in Souss-Massa (Morocco). *Euro-Mediterranean J Environ Integrat*. 2020;6(1):1. <https://doi.org/10.1007/s41207-020-00207-6>.
19. Seif-Ennasr M, Bouchaou L, Brouziyne Y, Chikhaoui M, Choukr-Allah R. Towards more sustainable and climate-smart water and agricultural systems: study case of the Souss Massa Basin in Morocco. *Front Sci Eng*. 2021. <https://doi.org/10.34874/IMIST.PRSM/fsejournal-v11i2.29003>.
20. Nightingale AJ, Eriksen S, Taylor M, Forsyth T, Pelling M, Newsham A, Boyd E, Brown K, Harvey B, Jones L, Bezner Kerr R, Mehta L, Naess LO, Ockwell D, Scoones I, Tanner T, Whitfield S. Beyond technical fixes: climate solutions and the great derangement. *Climate Dev*. 2020;12(4):343–52. <https://doi.org/10.1080/17565529.2019.1624495>.
21. Alves F, Caeiro S, Azeiteiro UM. Lay rationalities of climate change. *Int J Climate Change Strategies Manag*. 2014;6(1):1756–8692. <https://doi.org/10.1108/IJCCSM-10-2013-0121>.
22. Parker C, Scott S, Geddes A. *Snowball sampling*. Thousand Oaks: SAGE Research Methods Foundations; 2019.
23. Bowen GA. Naturalistic inquiry and the saturation concept: a research note. *Qual Res*. 2008;8(1):137–52. <https://doi.org/10.1177/1468794107085301>.
24. Van Praag L, Ou-Salah L, Hut E, Zickgraf C. Migration and environmental change in morocco in: search for linkages between migration aspirations and (Perceived) environmental changes. Springer Nature: Cham; 2021.
25. Sanders JE. Muslim perspectives and the politics of climate change. In: Duerk JA, editor. *Environmental philosophy, politics, and policy*. Lanham: Rowman & Littlefield; 2021.
26. Shuttleworth JM, Wylie S. The global citizen and religious position statements on climate change. *Soc Stud Res Pract*. 2019;14(2):212–24. <https://doi.org/10.1108/SSRP-05-2019-0028>.
27. Burck J, Uhlich T, Bals C, Höhne N, Nascimento L, Tavares M, Strietzel E. CCPI—Climate change performance index. Berlin: Germanwatch New Climate Institute, and Climate Action Network International; 2022.
28. Dabla-Norris E, Helbling T, Khalid S, Khan H, Magistretti G, Sollaci A, Srinivasan K. Public perceptions of climate mitigation policies: evidence from cross-country surveys. Staff discussion note SDN2023/002 2023. Washington, DC: International Monetary Fund; 2023.
29. Ameur F, Kuper M, Lejars C, Dugué P. Prosper, survive or exit: Contrasted fortunes of farmers in the groundwater economy in the Saiss plain (Morocco). *Agric Water Manag*. 2017;191:207–17. <https://doi.org/10.1016/j.agwat.2017.06.014>.

30. Bouras E, Jarlan L, Khabba S, Er-Raki S, Dezetter A, Sghir F, Trambly Y. Assessing the impact of global climate changes on irrigated wheat yields and water requirements in a semi-arid environment of Morocco. *Sci Reports*. 2019. <https://doi.org/10.1038/s41598-019-55251-2>.
31. Hssaisoune M, Bouchaou L, Sifeddine A, Bouimetarhan I, Chehbouni A. Moroccan groundwater resources and evolution with global climate changes. *Geosciences*. 2020. <https://doi.org/10.3390/geosciences10020081>.
32. Adamo G, Willis M. The omnipresent role of technology in social-ecological systems. In: Nurcan S, Opdahl AL, Mouratidis H, Tsohou A, editors. *Research challenges in information science information science and the connected world 2023*. Cham: Springer Nature Switzerland; 2023. p. 87–102.
33. IPBES. Summary for policymakers of the global assessment report on biodiversity and ecosystem services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services. S Díaz, J Settele, ES Brondízio ES, HT Ngo, M Guèze, J Agard, A Arneth, P Balvanera, KA Brauman, SHM Butchart, KMA Chan, LA Garibaldi, K Ichii, J Liu, SM Subramanian, GF Midgley, P Miloslavich, Z Molnár, D Obura, A Pfaff, S Polasky, A Purvis, J Razzaque, B Reyers, R Roy Chowdhury, YJ Shin, IJ Visseren-Hamakers, KJ Willis, CN Zayas. 2019. IPBES secretariat. Bonn, Germany. 56.
34. Daher B, Mohtar RH. Water-energy-food sustainable development goals in morocco. *Encyclopedia UN Sustain Develop Goals*. 2021. [https://doi.org/10.1007/978-3-319-70061-8\\_133-1](https://doi.org/10.1007/978-3-319-70061-8_133-1).
35. Jelti F, Saadani R, Rahmoune M, Talidi A. Evaluation of the potential impact of electric vehicles in Morocco: a literature review. 2022 14th International Colloquium of Logistics and Supply Chain Management (LOGISTIQUA). 2022. <https://doi.org/10.1109/LOGISTIQUA55056.2022.9938055>.
36. ONEE. Energie Electrique—Chiffres clés 2021. 2022. Office National de l'Electricité et de l'Eau Potable (ONEE).
37. Richter JL. A circular economy approach is needed for electric vehicles. *Nat Electron*. 2022. <https://doi.org/10.1038/s41928-021-00711-9>.
38. Dardonville M, Bockstaller C, Villerd J, Therond O. Resilience of agricultural systems: Biodiversity-based systems are stable, while intensified ones are resistant and high-yielding. *Agric Syst*. 2022;197: 103365. <https://doi.org/10.1016/j.agsy.2022.103365>.
39. El Ghmari H, Harbouze R, El Bilali H. Pathways of transition to organic agriculture in Morocco. *World*. 2022;3(3):1–18.
40. Benabdelkader M, Saifi R, Saifi H. Sustainable agriculture in some Arab Maghreb countries. In: Abu-hashim M, KhebourAllouche F, Negm A, editors. *Agro-environmental sustainability in MENA regions*. Cham: Springer International Publishing; 2021. p. 233–61.
41. El Mekkaoui N, Forouheshfar Y, Loukili S. The Social and Solidarity Economy (SSE) in Morocco 2021 (No. 50). EMNES Working Paper.
42. Ministère du Tourisme, de l'Artisanat et de l'Economie Sociale et Solidaire. *Stratégie Nationale de l'Economie Sociale Solidaire (ESS)*. 2023. <https://mtaess.gov.ma/fr/economie-sociale-et-solidaire/strategie-de-leconomie-sociale/>. Accessed 29 Apr 2023.
43. Bouhazzama M, Guenaoui A. The Moroccan Women's Cooperative in Response to Lasting Impacts: Social Cohesion, Solidarity and Inclusion (SSRN Scholarly Paper No. 3629028). 2020. <https://papers.ssrn.com/abstract=3629028>.
44. Ferreira Fernandes CS, Alves F, Loureiro J. Human mobility and environmental degradation: Shaping rural Morocco. *Int Migr*. 2023. <https://doi.org/10.1111/imig.13198>.
45. The World Bank. *Morocco—country climate and development report*. Washington D.C: The World Bank Group; 2022.
46. Kuckartz U, Rädiker S. *Focused analysis of qualitative interviews with MAXQDA: step by step*. Berlin: MAXQDA Press; 2020.
47. Baraldi C. An interactional perspective on interpreting as mediation. *Languages Cult Med*. 2014. <https://doi.org/10.7358/lcm-2014-0102-bara>.
48. Farbotko C, Boas I, Dahm R, Kitara T, Lusama T, Tanielu T. Reclaiming open climate adaptation futures. *Nat Clim Chang*. 2023;13:750–1. <https://doi.org/10.1038/s41558-023-01733-1>.

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