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Ecology of Knowledge in the Context of the Implementation of Climate Change Adaptation Measures in Developing Countries

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Abstract

Climate change involves a series of transformations in the synoptic systems of the planet. Its effects are not equitable, so the onus falls on the most vulnerable. Countries considered to be developing tend to be more vulnerable and therefore need to implement adaptation measures. However, these measures are not always viable within the social, environmental, institutional, geophysical, and economic dimensions, especially in the latter. Developing countries often need funding from international multilateral networks to make adaptation measures viable. Yet, projects that receive financing usually reproduce colonial aspects by erasing local knowledge, as in the case of measures implemented in São Tomé and Príncipe, and Bhutan. The essence of the ecology of knowledge concept can be a way for local knowledge to be valued and to be part of adaptation measures projects in countries considered to be developing.

Keywords: Ecology of knowledge, Climate change, Adaptation measures, Developing countries

1. Introduction

This article aims to understand how the multiplicity of knowledge can contribute to enabling the implementation of adaptation measures in countries considered to be developing to face the effects of climate change. For this, it is necessary, within the scope of this article, to discuss the concept of ecology of knowledge and the historical and scientific context in which it is based, identify cases of implementation of adaptation measures in developing countries and analyze how this implementation was carried out.

Climate change involves a series of transformations in the synoptic systems of the planet, generated directly or indirectly by human actions, which alter the pattern of functioning of the environment at local, regional and global levels (Nobre, 2010). The effects of climate change are not equitable, and neither are the ways to adapt to them. Poor countries and populations with a high rate of violence, difficulties in governance, and little access to essential services (IPCC, 2022), in general, suffer more from extreme events than developed countries because they are more vulnerable (Wolf, 2011). Vulnerability is a term that historically has gone through several understandings. Recently, the Intergovernmental Panel on Climate Change - IPCC (2022), in its AR6 report, understands that vulnerability can be referred to both an ecosystem and human populations and varies across locations. When it comes to human populations, it can be associated with different processes such as land use and occupation, development patterns, inequities, marginalization, and historical colonialism.

It is from the understanding of vulnerability that risks begin to take shape. According to Cutter et al. (2003), risk is a probabilistic and objective measure of the occurrence of a given adverse event, or a set of them. In such context, the risk will interact directly with mitigation and adaptation actions, thus being able to reduce the potential danger that can reach both physical and social spheres.

Adaptation can be understood as an adjustment in ecological, social, or economic systems, a response to the effects and impacts of threats such as climate change. It occurs systemically, integrated into cultural, demographic, and economic contexts (Adger et al., 2005). Measures aimed at adaptation act in a scenario of perceived vulnerability to expand adaptive capacity and reduce risks (Smit & Wandel, 2006; IPCC, 2022). The implementation of adaptation measures will depend on ‘the capacity and effectiveness of governance and decision-making processes.’ (IPCC 2022, p. 20), and on its feasibility (IPCC, 2022).

The ability to adapt concerns the financial resources and the forms of governmental and social organization to implement such measures, which in countries permeated by poverty, leave gaps between what needs to be done and what can be done (IPCC, 2022). This gap is essential to understand some aspects related to the feasibility of a given adaptation measure in specific contexts.

Effectiveness is understood from the point of view of the measure’s technological capacity to reduce climate risks (IPCC, 2022); already a viable measure for the IPCC (2022), it takes into account institutional, sociocultural, environmental, financial, technological, and geophysical.

Fig. 1 qualitatively summarizes some climate responses, adaptation options, and their

relationships with risk sectors and groups and their potential viability to guide decision makers. It is important to note that in low-income groups, which fall within the context of the object of this research, the uncertainties of adaptation measures are still prominent, most of them being of medium to low confidence and with uncertain, negative, unassessed or unrecognized effects with little evidence. Another important highlight is that disaster risk management and the energy system were not evaluated, indicating a need to carry out more studies on poverty and the adaptation measures described in the scientific literature.

Figure 1. Potential risk sectors, groups, and feasibility of adaptive options and climate responses (Source: IPCC, 2022 (adapted).)

In the field of potential viability, it is noted that there are mainly institutional challenges for the measures described to be feasible, followed by economic and social challenges. The results presented in Figure 1 need to be looked at very carefully by decision-makers as they represent a general synthesis of all the research compiled by the IPCC. Each country has its peculiarities, and one must have a look considering the difficulties and facilities considering the context in which the measure will be implemented. It's opportune to mention, in such context, that Implementing an adaptation measure that is not feasible on some dimensions can lead to a maladaptation measure (IPCC, 2022).

According to the IPCC (2022), one way to prevent maladaptation and increase climate resilience is to increase participation in decision-making and carry out planning that brings

together local, scientific, indigenous knowledge and cultural values of each location to create cross-border cooperation and management networks.

These cross-border networks of cooperation and management open a field of discussion in which the concept of ecology of knowledge can be inserted within the context of planning the implementation of adaptive measures. Developing countries tend to be more vulnerable to climate change and need targeted efforts to implement adaptation measures (Adger et al., 2003). However, with few financial resources, some important adaptation measures tend to become unfeasible from an economic point of view. Although it is not the only dimension responsible for making an adaptation measure viable or unfeasible, in the case of countries considered to be developing with few financial resources, this dimension becomes hugely relevant. Therefore, poor countries depend on actions and financing from other countries (Adger et al., 2003, 2007).

To ensure that the needs for financial resources were quickly met, the Copenhagen Accord was signed in 2009, at the fifteenth Conference of the Parties (COP 15), with one of the purposes of establishing support for the reduction of vulnerabilities and adaptation to climate change (Conway & Mustelin, 2014), especially aimed at countries considered to be less developed (Copenhagen Accord, 2009).

These cross-border funding and governance networks for the implementation of adaptation measures, for example, the Global Environment Facility (GEF), the United Nations Development Program (UNDP) itself, and the various instruments of the United Nations Framework Convention on Climate Change (UNFCCC). In addition to being based in Northern countries, planning and financing decisions tend to prioritize projects that are top-down implementation, disregarding local needs, contexts, and demands, with the justification of being faster to implement, more controllable and more efficient (Pisor et al., 2022), bumping into other dimensions of feasibility through the erasure of local knowledge. This erasure is not something recent; it can be seen as a reproduction of aspects of past colonial relations.

2. Method

To achieve the objectives of this article, a systematic bibliographic review was carried out on the subject, the literature being searched in the Elsevier, Web of Science, and Google Scholar databases. This review was made through keywords such as: adaptation measures to climate change, climate change in developing countries, adaptation measures in developing countries, ecology of knowledge, modern thinking and decolonization and climate change. This literature review was conducted in three languages: Portuguese, English and Spanish. Authors were restricted according to their adherence and relevance both in terms of publication and in terms of the place of production of the specific knowledge to be analyzed. In addition, the summary for decision-makers from the IPCC AR6 report on impacts, adaptation and vulnerability was used.

The selection and analysis of the articles and parts of the AR6 were made from the perspective of Bardin (2009), who proposes a method of document analysis, but which can

also be applied to scientific articles that go through some stages. First, the texts to be analyzed are selected, and a floating reading of the body of the texts is carried out; then, the themes that relate to the scope of the project are organized, to finally carry out the analysis of the relevant parts for the research (Bardin, 2009).

The article is divided into three parts. It starts with the understanding of the concept of ecology of knowledge as opposed to a context of hegemonic knowledge. Next, some cases of attempts to implement adaptation measures in São Tomé and Príncipe and Bhutan, two countries considered to be developing are discussed. Finally, the relationship between the concept and the cases presented is discussed.

3. Results

3.1 From Monocultures of the Mind to the Ecology of Knowledge

The importance of modern thinking in building the world in which we live is undeniable. It is due to the scientific knowledge we are able to advance the understanding of natural phenomena and its transformations. Without this epistemology the knowledge we have about climate change, proving that human beings are the causative actors of such transformations, could never be produced. The very measures necessary to be taken to avoid a global catastrophe in the coming years are the result of analyzes and representations of reality whose origins lie in modern scientific knowledge.

Modernity is the result of the scientific revolution of the 16th century, arising from Enlightenment thinkers, especially Bacon and Descartes. This way of thinking paradigmatically segregated what we now call the common sense of scientific knowledge through the stipulation of a rigorous, systematic, and observational method of natural phenomena that can be reproduced in controlled environments anywhere in the world. The representation of the natural world is guided and made possible by mathematical thinking, considering the segregation of human beings and nature and excluding everything that cannot be quantified from the scope of the scientific approach (Santos, 2008). In this way, a universal way of producing knowledge would have been created, in which the subject, far from his object, would be able to elaborate a neutral and standardized representation (Quijano, 1992).

Some authors, such as Quijano (1992), Dussel (1994), and Santos (2007) state that there is another origin of modern thought that precedes the scientific discourses of Bacon and Descartes and is established from the colonial relations between Europe and America. In other words, the roots of modernity are fixed in Europe's relations of domination and emancipation with other ontologies (Quijano, 1992). Hegel, when dealing with development, is a European civilization that holds the only acceptable mode of development. The Orient is seen as developing in early processes but still strongly marked with aspects associated with the primitive. In this philosopher’s view, Africa and America are not even considered in this discussion (Dussel, 1994).

The hegemony of European thought still permeates current scientific knowledge and carries aspects of superiority, imposing its standards of producing knowledge (Quijano, 1992) on

other forms of knowledge to the point of invalidating them (Harding, 2007). This Eurocentrism of knowledge as the only form existing within recognition as valid is what Vandana Shiva (2003) calls monocultures of the mind. Any other form of knowledge is erased, so that diversity of knowledge is lost in the countries of the South, and Western scientific knowledge becomes dominant (Shiva, 2003).

There is, therefore, an abyss between the knowledge of the South and the North (Santos 2007). Such segregation is a wound caused by the historical reproductions of aspects of colonial thoughts that were perpetuated by modernity and are maintained in the forms of production of current knowledge (Shiva, 2003; Santos, 2007; Harding, 2007; Yehia, 2007; Miglievich-Ribeiro, 2014).

To break with this epistemic coloniality, Santos (2007) presents the concept of ecology of knowledge. This concept addresses "learning from the South, using an epistemology of the South" (Santos, 2007, p.22). In this way, there is a rupture in the hierarchies between the forms of knowledge and the recognition that other types of knowledge and epistemologies are also valid in view of their social relevance in practice (Santos, 2009). The author uses the term "ecology" because he understands that it is necessary to recognize that knowledge is heterogeneous, one of which is modern scientific knowledge (Santos, 2007), which is also local knowledge (Shiva, 2003). These multiple local knowledges act in an interconnected way to form an "interknowledge" (Santos, 2007), or a networked knowledge (Yehia, 2007).

This theoretical-philosophical discussion exposed so far is materialized in at least two concrete cases of implementation of climate change measures in countries considered developed, in which the knowledge of local populations was not considered.

3.2 Adaptation Measures to Climate Change in Developing Countries

Climate change means any changes caused by anthropogenic interference that occur on a particular time scale and imply changes in the Earth's climate system (IPCC, 2022). Thus, climate change is equivalent to systematic changes measured by statistical models about precipitation, temperature, winds, or atmospheric pressure in a given period of time (IPCC, 2022). Such changes are already perceptible from a scientific point of view, with an observable and verifiable rise in sea level, irregularity in precipitation, increase in the average temperature of the Earth's surface, greater frequency of extreme weather events (such as hurricanes, typhoons, cyclones, torrential rains) and shrinkage of the cryosphere, excluding natural phenomena. In this context, adaptation actions to the adverse effects of climate change are necessary, especially in underdeveloped countries that are already being more affected than developed countries by these anthropogenic changes in the climate.

Adaptation to climate change in developing countries are vital and must be addressed as a top priority. One of the major problems for consolidating a strategic plan to adapt to such changes resides in the fact that such changes reside in the existence of limitations arising from financial resources and human capacity (UNFCCC, 2018). For a strategy to be implemented, certain conditions must first be addressed and resolved. Programs that are intended to be effective require rapid resolution of tensions around alleviating social inequality, improving

food security, reducing ecosystem services and biodiversity, and reducing land use. The multi-sectoral adaptation that alludes to the management of natural capital that covers several sectors must initially be based on the internalization of the governance of the actors that use these natural resources (UNFCCC, 2018).

3.2.1 Ponta Baleia Case Study in São Tomé and Príncipe: Resistance to Adaptation

Small Island Developing States (SIDS) are nations that, in general, have a series of economic, social, and environmental peculiarities in common, such as commercial limitations and dependencies, problems of public administration, demographic growth, great demand for resources, etc. (Briguglio, 1995). SIDS, despite contributing very little to global warming, are generally highly vulnerable to the effects of climate change and increased sea level rise (Wong, 2011).

São Tomé and Príncipe is a small island considered under development located in the Atlantic Ocean in Africa; it has about 210,000 inhabitants and has an economy focused on the export of commodities and which is highly vulnerable to climate change, having as the main climate impacts: storms, lightning, floods, droughts, and sea level rise. Some of these impacts are also present in the community located in the District of Caué, Ponta Baleia, which is one of the most vulnerable regions of the island, with a population of 7,500 inhabitants. Most of the inhabitants live in a state considered to be of absolute poverty and live off irrigation agriculture, extensive livestock (pigs and chickens), palm wine, fishing, local trades, and services. The population faces problems related to energy, basic sanitation, water supply, education, health, and transport, and the main concerns are the increasing occurrences of landslides and floods, in addition to the duration of the latter since there is no drainage system in the region (Mikulewicz & Podgórska, 2020).

According to Chou et al. (2020) projections point to an increase of 3 °C on the islands of São Tomé and Príncipe, hot nights and days will be more frequent, considering the worst of the scenarios projected by the IPCC, a decrease in precipitation is expected. Even with a drier climate, it is expected that heavy rains will be more frequent, especially in the southern portion of the island of São Tomé, where Ponta Baleia is located.

The scenario described indicates the great need to implement adaptation measures for this community. However, Mikulewicz and Podgórska (2020) identified enormous resistance from the population to a project involving the UNDP and the country's government to reduce environmental risks. According to the authors, the project was intended to build pigpens, which could increase the population's quality of life by reducing exposure to diseases. However, this was not a local demand, nor was it considered sustainable for these residents. What residents needed, according to interviews conducted by Mikulewicz and Podgórska (2020), were decent housing, as is evident in the photo in Fig. 2.

Figure 2. Village center with local houses and free animal husbandry (Mikulewicz & Podgórska, 2020)

This was not the first time that the community's knowledge regarding what is best for them was ignored. According to reports, all projects aimed at Ponta Baleia for adaptation to climate change were imposed in this way. On a previous occasion, the GEF, together with the UNDP, financed the implantation of photovoltaic cells to generate electric energy that, in theory, would feed a freezer that would store fish to be commercialized. The freezer never worked and caused damage to the community. Other projects were proposed on other occasions, but many of them were left with promises that never materialized. In several of these cases, the population came to propose other alternatives, but they were never heard (Mikulewicz & Podgórska, 2020).

3.2.2 Bhutan Case Study: Glacial Lake Outburst Floods

Bhutan is a developing country located in the eastern portion of the Himalayas, in a region called the Hindu Kush-Himalayan, which contains the largest area and volume covered by ice and permafrost outside the Polar Regions. Much of this ice is melting due to rising global and local temperatures. It is a mountainous region with altitude variations that starts from 100 m in the south, reaching 7,500 m in the extreme north. To facilitate the availability of water, most housing and agricultural areas are located close to rivers since pumping water to higher areas becomes impracticable. The main economic activities are the sale of electricity, agriculture, animal husbandry, forestry resources, extractivism, and tourism, and a large part of the population that depends on agriculture is below the poverty line. Changes in the local climate put economic activities at risk, causing the country to be considered as having great vulnerability due to the high risks of floods caused by the melting of glacial lakes, known as

Glacial Lake Outburst Floods (GLOFs) (Meenawat & Sovacool, 2011).

In the most critical scenario projected by the IPCC (RCP 8.5), it is expected that by the end of the century, the minimum and maximum temperatures of the Himalayas region will increase at all times of the year, ranging from 0.3–1.1 ℃/decade for minimum temperatures and 0.3–1.0 ℃/decade for maximum temperatures. Such changes tend to be greater at higher altitudes, consequently increasing the melting of glaciers in the region (Dimri et al., 2018). These local changes may influence a regional scale. This is because the flow of water from many rivers of great social and economic significance in Asia, such as the Yellow River, Yangtze, and Ganges, are fed by melting Himalayan glaciers. Depending on the river, this contribution can reach up to 45% of its entire flow. (Xu et al., 2007). Climate change in the Himalayan region can cause cascading effects on socioecological systems, such as indirect extinction due to loss of critical species, an increase in the number of floods, need to further increase the adaptive capacity of different populations (Xu et al., 2009). Otherwise, increased occurrences of fires in blue pine forests (Vilà-Vilardell et al., 2020), negative impacts on food production, such as potatoes, increase in the number of insects considered pests and invasive plants, in addition to the loss of hands young people who abandon agriculture due to the increase in the difficulties of producing food (Suberi et al., 2018).

Bhutan was one of the first to receive funding from the GEF and UNDP for the implementation of adaptation measures to the GLOFs. In 2011, there were two adaptation projects. One corresponded to the creation of a regional database, and the other involving the reduction of water levels in glacial lakes with a pump, the installation of an alert system, the creation of community awareness, and the zoning of habitable and non-habitable areas. All the objectives of the latter encountered difficulties in implementation. First, access to the regions of GLOFs was topographically and climatically tricky to access, which made it difficult to install the water pump. Additionally, it would take a long time for the installation to be completed. Even after implemented, the pump would be efficient straightaway, since along time wait would be needed for it to pump out significant amount of water to reduce the risks of flood. Second, the alert system was designed for manual activation what would put the lives of workers responsible for monitoring it at risk. Third, the discussions with local people often did not progress due to the low perception of risks, the fact that most of the population was illiterate and the fact that there was little participation of women during the discussions, added to a politically and institutionally vulnerable State (Meenawat & Sovacool, 2011).

3.3 Ecology of Knowledge in the Cases Raised

In the cases of São Tomé and Príncipe and Bhutan, the adaptation measures designed for the two countries involved multilateral networks, or development actors, to finance the projects, which is often, in fact, necessary in countries that are under associated socio-environmental crises, mainly to extreme poverty to make adaptation measures economically viable.

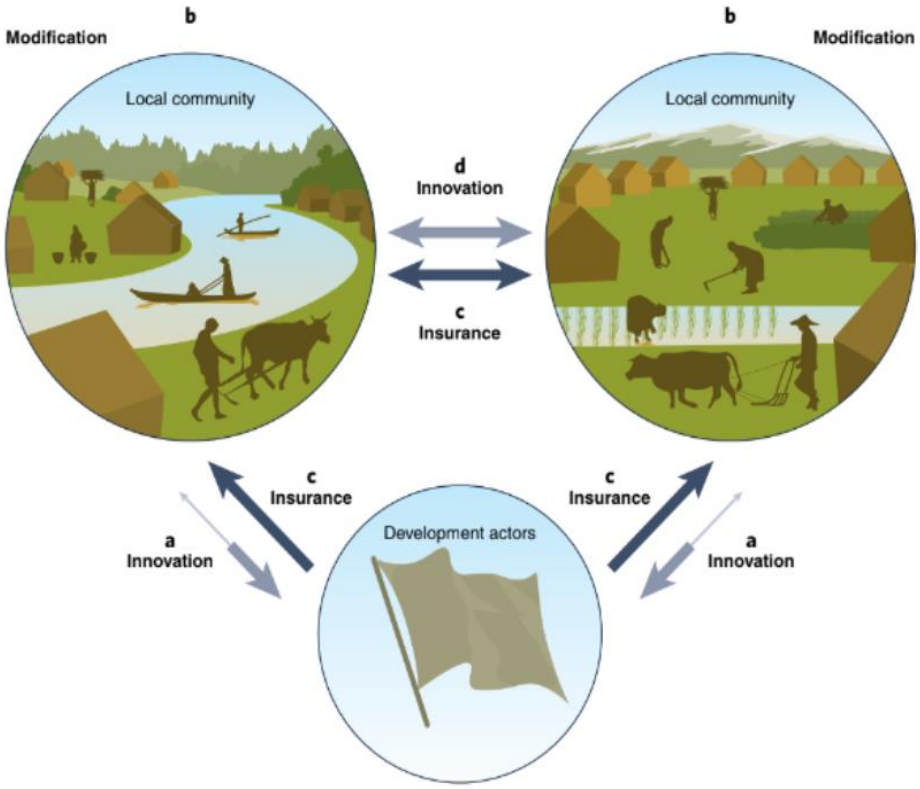

Figure 3. Relations between development actors and local knowledge (Pisor et al., 2022)

Fig. 3 illustrates the relationships between these multilateral funding networks and local communities with their knowledge. In this figure, the arrows indicated by the letter “a” represent the power asymmetries between development actors and those who will receive adaptation measures, demonstrating that capital holders would ideally maintain an initial relationship, but would be open to learning about new solutions from the communities. Such solutions could be put into practice, eliminating implementation barriers to generate experimentation (b) in an environment of information and knowledge exchange between communities and providing support to increase experimentation (c). Finally, this process could generate horizontal relationships between different communities, facilitating the adoption of adaptation measures that best suit their realities (d) (Pisor et al., 2022). In this idealization, there would be an appreciation of the ecology of knowledge, so that local knowledge would gain strength and would be seen as extremely important for the planning of measures to adapt to climate change. Such appreciation dialogues with the concept of ecology of knowledge. However, the cases presented demonstrate implementations that go to the opposite side of this.

Local knowledge in both countries was not incorporated or even considered in the projects and implementation of adaptation measures. It is observed, therefore, that there was a reproduction of aspects of colonialism in the sense that the developers and funders of the projects, holding the scientific knowledge and in the position of taking development through

adaptation measures to those who supposedly do not know how to deal with the effects of climate change.

According to Wong (2011), many islanders have essential local knowledge that has already been used to adapt to sea level rise and natural disasters that could serve as an inspiration for the implementation of adaptation measures to the effects of climate change in SIDS. In the case of São Tomé and Príncipe, resistance movements were created against implementing projects that did not consider their real needs. However, the way it was implemented, considering European scientific knowledge without considering the plurality of knowledge, generated conflicts that resulted in resistance to any adaptation measure that is carried out according to the previous ones. It is noticed that the project had no social viability, which is considered essential for adaptation, according to the IPCC (2022). In this case, considering the ecology of knowledge during the elaboration of the maybe would have generated positive results, inclusively and taking into account the needs and demands of local populations.

In the case of Bhutan, according to the authors Meenawat & Sovacool (2011), participation and local knowledge were not very evident, which does not mean that this knowledge does not exist. Historically, the population of the Himalayas has developed its own measures of adaptation to the gradual climate changes of the past (Xu et al., 2009), which may also be occurring in the present times for some effects of climate change. Suberi et al. (2018), for example, identified that in agriculture some adaptation measures for more immediate effects are already being developed and implemented by the local population, but there is little local knowledge on how to face these effects in the long term. In fact, other authors such as Choden, Keenan, and Nitschke (2020) consider that investment in education would be a way to reduce inequality and vulnerability of the population of Bhutan. However, they also suggest that adaptation projects be done from a bottom-up perspective. The authors, using a perspective that includes the essence of the ecology of knowledge, identified that vulnerabilities were different between each population in the country. These authors also noted that diversification of the source of income, training, creation of alternative routes, and reduction of dependence on only a natural resource would increase the adaptive capacities of the most vulnerable populations (Choden, Keenan & Nitschke, 2020).

Even with external investments in high technology, as in the cases presented by Meenawat and Sovacool (2011), the low environmental, geophysical, institutional, and social feasibility is a problem for implementing the proposed adaptive measures. Only technical knowledge, the fruit of modern science, is insufficient for adaptation (Sovacool et al., 2012). The ecology of knowledge applied to this case could be essential to create multiple adaptive measures, which, when considered together, could expand adaptation to climate change.

If adaptation, according to Adger et al. (2005) are, adjustments in ecological, social, or economic systems, which occur systematically and integrated into cultural, demographic, and economic contexts. Moreover, from the point of view of the ecology of knowledge, it is necessary to consider the scientific results and data and technologies. However, it is also necessary to consider the forms of local thought, carrying the essence of ecology of knowledge, as in a certain way is being put in the AR6 of the IPCC (2022). As much as

multilateral financing networks can make adaptation measures for poor countries economically feasible, it does not mean that this same measure is materially viable when considering the social, environmental, institutional, and geophysical dimensions, as shown in the cases presented.

4. Conclusions

This article discusses how the concept of ecology of knowledge could contribute to the construction of an inclusive science, effectively implementing adaptive measures in poor countries. For this, the concept of ecology of knowledge was presented, as opposed to colonial aspects of modern scientific thought, in addition to case studies on the resistance of the populations of Ponta Baleia in São Tomé and Príncipe. Moreover, it was presented the economic difficulties of access to the implementation of technological measures, which is necessary to reduce the vulnerability of the population of Bhutan. Both cases presented colonial aspects in the form of planning and (attempts at) implementation, colliding with social viability in the first case and social, institutional, environmental, and geophysical in the second, even though external financing networks have increased the economic viability of these projects.

Developing countries are the most affected by climate change due to the few financial, technological, and socio-economic resources needed to adapt to climate change. These particularities, often consequences of colonial models of exploitation (from capitalist countries centered on peripheral countries to this model), for example, exacerbate the existing difference in the fight against extreme events in developed and underdeveloped countries. But, even in this context of continued international rhetoric (by developed countries, in particular) to enable the necessary financing of climate adaptation in poor countries, alternative forms of knowledge for the populations of such countries (the most vulnerable to the impacts of climate change, in case) – as observed by the resistance of the people of Ponta Baleia in São Tomé and Príncipe – can bring a new and, sometimes, more effective ways of implementing climate adaptation.

Although the so-called development actors play an essential role in the economic viability of adaptation measures, considering, from the planning stage, as valid other forms of knowledge through the essence of the concept of ecology of knowledge can bring to the light of knowledge measures of adaptation that are also viable in other dimensions in developing countries.

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