Essay

From the low deciduous forest to the traditional silvopastoral system in the Sierra de Huautla, Morelos

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Abstract

Currently, the Sierra de Huautla Biosphere Reserve (Rebiosh) is considered the last conserved stronghold of the low deciduous forest (SBC) of Mexico. In this document this approach is discussed and proposed as a traditional agroecosystem with silvopastoral management, with historical development and antecedents of use prior to the arrival of cattle in colonial times and a current animal load above technical parameters, in addition to other parameters that support the creation of an agroecosystem whose ecological behavior is close to the SBC. This situation is complicated by the creation of the Rebiosh, whose management plan ignores the traditional use of native usufructuaries and restrictions and criminalization are applied to traditional users; without considering alternative ways of meeting the needs not covered by the provisions of the protected natural area. The operation of the traditional silvopastoral system is described and it is concluded with the need to deepen its understanding, which allows, through participatory processes, the construction of resources that strengthen traditional agroforestry systems and the vision of the users to include in the Plan of Handling the Rebiosh.

Keywords: Biosphere reserve, protected natural area, traditional silvopastoral systems.

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Nature conservation is one of the issues on the world agenda with high international priority, protected natural areas (ANP) are conceived as one of the most widely used strategies globally to protect ecosystems (Hockings, 2003). The ANP date back to the mid-19th century and were created with the aim of isolating so-called 'natural' areas but with the influence of western society (Durand and Vázquez, 2011).

The justification in Mexico for the creation of ANP is argued by the deforestation rate, which for 1976 was 600 000 ha year^{-1}, increasing in 2000 to more than 1 000 000 ha, of which 60% are tropical and subtropical forests (Velázquez *et al*., 2002). In order to serve these areas in around 30 years, the Mexican government put together environmental laws, policies and institutions (García and Toledo, 2008) and established different types of ANP, giving preference to the biosphere reserve.

As a result of these actions, between 1990 and 2009 the number of ANP increased from 76 to 166, with more than 23 000 000, almost 12% of the national surface became part of one of the ANP categories (CONANP, 2008). With this large area it is intended to protect biodiversity, but what happens to the usufructuaries of the resources?, since in these ANP there are human groups that depend on natural resources to cover their basic needs, a situation that precedes the arrival of the Spanish.

With the creation of ANP, social property lands are included, which when applying the norms negatively impacts the forms of traditional use and conservation. From an anthropological perspective, ANP are spaces with social and scientific interaction. Unfortunately, in reality they become their contradiction due to the imposition by external agents on the communities and by interests different from them (Descola and Palsson, 2001; Haller and Galvin, 2008), the result is a space in conflict. The implementation of ANP currently produces negative consequences for local populations (Redford and Fearn, 2007). The priority of biological interests is reflected in the fact that 60% of the ANP analyzed prevented the use of traditional land (Figueroa and Sánchez, 2008), which generates conflicts with local actors, due to impeding the use of resources on which it is based their survival.

The ANP are governed by a management plan, in which the objectives that define the programs, projects and strategies for their operation are set. In addition, it includes a legal framework based on the General Law of Ecological Balance and Environmental Protection (LGEEPA, 2005). Conflicts with communities are caused by the foundations of public policies: conservation interests and the commodification of nature (Hernández and Hernández, 2015).

From a critical stance, this work starts from the perspective of local actors and establishes as a hypothesis, the historical existence of a silvopastoral system in REBIOSH, through which a use of the resources of vegetation, land has been carried out. and water and for this reason it is currently a modified agroecosystem product of livestock management, of the practice of traditional agriculture, the use of plant and animal resources, whose expression is manifested through systems that apparently are similar to the low deciduous forest.

Thus, it’s had a regional history of use of natural resources, fauna and flora, which is part of the food security of the peasant communities to which the land legally belongs, there is a tradition of rational use and a vision of conservation, which are characteristic typical of native

Mesoamerican cultures which still survives in the peasants of Morelos. The use of natural resources has been shaped in the last 500 years towards exploitation through livestock, the result of which is manifested through the creation of specialized traditional agrosilvopastoral systems, whose plant components resemble the low deciduous forest and are part of the rural culture of the region.

Methods and techniques of investigation

Study site

The Rebiosh is located in the southern part of the state of Morelos, Mexico, to the south it borders the states of Guerrero and Puebla (Figure 1). By 2007, 31 communities, with 23 544 inhabitants, had their territory or part of it included within the borders of the Rebiosh (INEGI, 2006). The municipalities and localities are: Amacuzac, Casahuatlan and Rancho Nuevo (municipality of Amacuzac); El vergel (municipality of Ayala); Chisco and Vicente Aranda (municipality of Jojutla); La Tigra, El Zapote, Tilzapotla, El Mango, El Salto and Los Tanques (municipality of Puente de Ixtla); Ixtlilco El Chico, Ixtlilco El Grande, El Limon, Los Sauces and Pitzotlan (municipality of Tepalcingo); Ajuchitlan, Santiopa, Chimalactlan, Coaxitlan, Huautla, Huaxtla, Huisaxtla, Nexpa, Xicatlacotla, Pueblo Viejo, Quilamula, Rancho Viejo, San Jose de Pala and Xochipala (municipality of Tlaquiltenango) (CONANP, 2006).

Figure 1. Location of the Sierra de Huautla. Elaboration based on CONANP (2006).

Methodological development

This document is descriptive, it begins with a review of the ANP as conserved spaces in biological terms, and is contrasted with the characteristics of the Sierra de Huautla, as an agroecosystem historically managed as silvopastoral. From this central point, 4 sections are developed around the Rebiosh, to explain the characteristics of the operation of the traditional agroforestry system.

Conservation in protected natural areas in Mexico

An ANP is an area within the national territory in which the nation exercises its sovereignty and jurisdiction, whose original environments have not been significantly altered by human activity or that require to be preserved and restored and are subject to the planned regime (LGEEPA, 2005). In this definition, an emphasis is placed on isolating the biodiversity of the human being, for which the ANP will be at risk and therefore it is a priority to "conserve" to preserve and restore.

It raises two questions about this idea. If the land was distributed to the ejidatarios almost a century ago, why now the nation must exercise its sovereignty and legislation over a territory that has another use? On the other hand, does the Rebiosh fulfill the characteristic of a conserved territory? And finally, are human groups that use resources predators by definition? Hernández (2015) affirms that in Mexico and worldwide, conservation is seen as an island separated from society and therefore there is a profound lack of social protection.

The protection of nature during the seventeenth and nineteenth centuries were led by the social elite that resided in developed and developing countries, this is where the largest conservation areas are established, these actions were also distinguished by protecting resources local actors considered a threat (Fisher *et al*., 2008). In the case of Africa, local hunters were positioned as a threat (Adams and McShane, 1992).

From this, a stream of ecologists began who, with the use of modern technology such as aerial and satellite photography, geopositioning systems, remote sensing, quantitative methodologies and from a vertical view (from top to bottom) identified the natural corridors where the maintenance of nature was still possible, which had been kept safe from human predation (Bennett, 1999). This vision continues to dominate, it is about conserving wildlife through the design of biological corridors where human settlements take a back seat. Therefore, human presence continues to be considered as a disturbance of ecosystem dynamics and a danger to wildlife (Fisher *et al*., 2008).

In the last third of the 20th century, the characteristic of scenic beauty was added to these spaces (Dudley, 2012), adding a mercantile value to the landscapes of the ANP (Hernández, 2007). Conservation in the ANP adheres to sustainable development, by signing the agreement called Agenda XXI, a fact that happened in 1992.

Sustainable development aims to find a formula that, without stopping economic growth, manages to advance in a new direction, where economic activities and management (and not only use and exploitation of nature) are consistent (Torres, 2013). Its epistemological base goes towards a physical science (green economy) and not the inclusion of the social sciences (political ecology) (Foldari and Tomassino, 2005). It should be noted that these conservation models and the development model are under political support to separate the sociocultural dimension and leave natural resources to the actors with greater power.

The biologist vision in the Sierra de Huautla Biosphere Reserve, Morelos

Rebiosh, like all ANP, must be governed by a management plan, in which the objectives are defined and the programs to be carried out are established that allow the conservation and, where appropriate, the commodification of nature. The interests of the ejidatarios, local actors who,

through the centuries, have used the resources and survived since their ancestors are not present, as evidenced by the archaeological zones and the recent history of the region. This turns out to be the fundamental problem, since the operation of the ANP means an expropriation of land and resources, limits traditional exploitation and criminalizes the use that peasants make, restricts usufructuary rights and is an attack on the native culture of exploitation of resources, all of which translates into a reduction in food sovereignty.

According to 20th century botanists, the dominant vegetation of REBIOSH is the SBC (Miranda and Hernández, 1963). The original surface of the SBC was 8% and its extension ranges from the north coast of the Mexican Pacific to Panama (Rzedowski, 1978; Janzen, 1988) and currently only 2% of the SBC is preserved (Janzen, 1988; Murphy and Lugo, 1986). Regarding the Balsas River basin, the SBC limits the northern part with the states of Puebla and Morelos (Rzedowski, 1978).

The Rebiosh, arose from the initiative and interest on the part of some academics from the Autonomous University of Morelos (UAEM) where they carried out taxonomic studies (Durand and Vazquez, 2011). Subsequently, the UAEM together with the Center for Biological Research and Conservation (CIBYC; formerly the Sierra de Huautla Environmental Education and Research Center (CEAMISH) and CONANP, signed a collaboration agreement in 1999 to establish the Rebiosh (López *et al*., 2017).

The initiative came from UAEM researchers and academics and not from local actors, this confirms what was mentioned by Almazan (2011) where conservation is the initiative of the experts, who consider the activities carried out by the farmers of the Rebiosh as a threat. On the other hand, the local actors of the Rebioh have a close relationship with natural resources, throughout history they have generated symbolisms, however, preservation considers these symbolisms a threat.

The Rebiosh management plan (CONANP, 2006) essentially has conservation from the researchers perspective, in this way, the objectives are established: preserve the region's natural habitats and fragile ecosystems; conserve existing biodiversity; contribute to the protection of the biodiversity of the SBC and lastly promote the economic-social development of the area, through the implementation of sustainable productive projects.

The objectives of the Rebiosh management plan are intended to counteract the following problem (CONANP, 2006): the processes of deforestation and change in land use, from forest to agricultural and livestock areas; poaching and the selective extraction of wild flora and fauna in these areas, as well as in those adjacent to forested areas, considering that the exploitation causes risks of disturbance; the loss of traditional agricultural practice due to modernization and greater impact on the ecosystem; lack of definition in land tenure and lack of application of the environmental legal framework; incidence of forest fires, product of slash-and-burn practices; lack of vigilance, lack of adequate planning instruments; lack of mechanisms that evaluate the contamination of bodies of water as well as the management of solid waste; contamination of aquifers and bodies of water, as well as some effects on plants and animals, due to mining activities.

With regard to fauna studies, fireflies are the most described species for Rebiosh, including the genera *Cratomorphus*, *Plateros*, *Photinus* and *Pyropygodes* (*P. huautlae*), as well as a taxonomic group of fireflies of the genus *Plateros*, which is called Huautlaensis (Zaragoza, 1999). There are relict populations of 44 species of butterflies that have been located on the northern slope of Cerro Frío (Tilzapotla), which are representative of a warm humid geological stage in this region and whose usual distribution occurs on the oceanic slope of the Sierra Madre del Sur, between Oaxaca and Nayarit (De La Maza *et al*., 1995). On the other hand, they recorded 66 species of mammals, 180 species of birds (50% of the known avifauna of Morelos), 63 species of reptiles, 11 species of amphibians and eight species of fish (Dorado, 1997).

With regard to environmental services, Rebiosh offers services to the inhabitants of southern Morelos, northern Guerrero, and the Mexcala and Río Balsas Basin. This is thanks to the surface runoff that comes down from the mountains and in turn supplies water to the Emiliano Zapata and Lorenzo Vázquez dams, among others (CONANP, 2006). It is possible that the assertion about biodiversity argued based on studies of wildlife, and that has served to argue the creation of REBIOSH, is true and that said fauna inhabits the traditional silvopastoral systems that producers have generated, which apparently they meet the same ecological conditions for these animal populations, therefore they subsist and develop in this modified condition of the low deciduous forest.

In the studies on biodiversity in Rebiosh, technology was used to characterize wild species, thanks to these tools, better precision was achieved as well as other ANP (Bennett, 1999). But this diagnosis is not for the service of local actors but for researchers and government authorities, therefore conservation continues to have the same exclusion essence (Fisher *et al*., 2008). In accordance with Rebiosh objectives, the management plan includes several conservation subprograms, in which emphasis is placed on management and tourism, public use and outdoor recreation. These components favor ecotourism projects that use scenic beauty (Dudley, 2012), where the beneficiaries are not necessarily local people.

Subsidy and support programs have been applied, including the Conservation Program for Sustainable Development (PROCODES), the Temporary Employment Program (PET), the Creole Corn Conservation Program (PROMAC) and the Species Conservation Program in Risk (PROCER) (Cruz *et al*., 2018) that has not contributed to reducing marginalization in the communities. In addition, workshops have been held on the use of medicinal plants, the use of firewood-saving stoves and the construction of nurseries for native plants (Durand and Vázquez, 2011).

At REBIOSH, these actions have not impacted what was expected by UAEM researchers and government authorities. For this reason, the present work argues that, given the lack of effectiveness of government programs and academia, it will be necessary to resume ancestral native conservation, whose knowledge and worldview are a guarantee of conservation, as has been demonstrated in the last 9000 years, despite 500 years of colonialism. The current peasant management is a strategy of diversification of the use of resources and through which the diversification of domesticated and wild species is created.

The zoning of the management plan of the Sierra de Huautla Biosphere Reserve, Morelos as criteria for discussion.

From the zoning of the Rebiosh, the conserved areas correspond to the class called conservation, which barely constitutes 9.3% of the total area and at the same time constitutes the area of interest for the producers to conserve. The rest is a contradiction for conservation, since 22.6% correspond to disturbed areas that the communities want to conserve, 29.2% correspond to areas where grazing is allowed in a non-intensive way and 36.8% correspond to the area where they are carried out. carrying out agricultural activities, this added reaches 88.6%, a very high amount if we are talking about an ANP.

On the other hand, the cattle population grazing in the Rebiosh is very high. The data from the last agricultural census is considered. In Rebiosh there are 24 668 head of cattle (INEGI, 2007), not including horses and mules or other livestock and wild species. If the range index established for Morelos is considered, which is 6.9 ha per animal unit (SAGARPA, 2014), to maintain this bovine population an area of more than 170 000 ha is required, which means that the bovine livestock population is approximately 300% higher than recommended load. For this reason, it cannot be considered a conserved area and, of course, the norms of an ANP will hardly be applied in a condition such as the one described.

To understand the Rebiosh as an agroforestry system, it can be done with a simple tour in the areas where cattle graze, the presence of pastures is appreciated, and the dominant trees are: cubatas, brasil, huizaches, cuhaulotes, huntinghuates, tecolhuixtle and other spices that are used as forage and the typical SBC species are found in areas with steeper slopes and stoniness, to such an extent that cattle cannot forage in those places and therefore are conserved.

Rebiosh as an expression of historical agrosilvopastoral management

To discuss whether the Rebiosh is preserved or not, it is important to recognize that historically it is a space where local actors developed survival strategies for many years. Which means that there are no natural ecosystems, and instead agroecosystems or historically occupied territories have been generated.

For Hernández and Ramos (1981) the agroecosystem is the ecosystem modified to a lesser or greater degree by man, to use natural resources in agricultural, livestock, forestry or wildlife production processes. This concept is created associated with the traditional agricultural technology approach (Hernádez *et al*., 1976; 1977). Currently, this historical vision can be contemplated with the approaches to comparative agriculture developed by Dumont (1952). From these approaches, the space currently occupied by the Rebiosh has a history of its use that includes thousands of years, the current ejidatarios manage the space according to their needs and thereby modify the natural expression of the vegetation, whose current characteristics they differ from the low deciduous forest.

The existence of human groups in the Rebioh dates back 22 000 years, as evidenced by the cave paintings with that antiquity, in the municipalities of Puente de Ixtla and Tlaquiltenango (Plancarte and Navarrete, 1911). The inhabitants of these places maintained contact with peoples of the plateau, the Huasteca, Guerrero and the Mixteca. These were hierarchical and well-organized

societies that used every inch of arable land, all kinds of vegetation and mineral products were exploited (lime, precious stones, native surface metals), the soil was intensively cultivated, they hunted and raised animals of very diverse nature (CONANP, 2006).

In mid-1523, the Villa de San Francisco Tlaquiltenango was founded, where the Spanish were interested in silver minerals, in Jojutla el Kaolin and black slate (Beltran, 1998). From these interests the mining estates developed, some of them established in 1774, as examples are San Esteban by Pedro Arechardi, Santisima Trinidad by Juan Antonio Pipino, Peñon Grande by José de la Borda, Santiago de Ignacio Loperena, Purisima by Angel Fernandez de Mendoza, San Francisco by Diego Ballesteros and finally the Peregrina by Diego Boquedano (Von Mentz, 1977).

The Sierra de Huautla was occupied with livestock, the large estates extended their territory through extensive cattle raising and surely equines, as work animals used in agricultural work and transportation. For the protection and management of livestock, isolated hamlets located within the Mountain range were founded and established, which later gave rise to current towns, such as Huitchila, Los Sauces, El Limón, Ixtlilco el Grande, El Tepehuaje, Sacapalco, Ajuchitlan, San José de Pala. These towns belonged to farms such as Tenextepango, Tenango, Chinameca, among others. Livestock provided meat, hides and work animals necessary in agriculture, of importance in the sugarcane exploitation whose specialty was concentrated in the valleys of Cuautla and Cuernavaca.

The agrosilvopastoral system of the Sierra de Huautla, Morelos

Livestock in the Rebiosh determines the dynamics of the communities, around it the agricultural cycle of the main crops was organized, since a deadline is established for the moment of sowing, depending on the departure of the livestock from the agricultural lands, in the same way it is done for the harvest. It is the farmers obligation to raise their crops before the introduction of livestock in the autumn-winter.

But also, it is related to festive activities and is an important part of the culture of the communities, the town fair is made with bulls, they are more than that, the fair is the bulls, no celebration is conceived without this popular form of fun, which has evolved from using local animals with a series of rituals and community organization, to the use of ‘game’ animals, specialized animals by specific selection, ridden no longer by the bravest young people in the locality, but by professional riders, whose presentation is quite a show, with high costs, which are paid by the people and the local organization of the fair.

Livestock is practiced throughout the study area, it is a rotating livestock based on the availability of forage and water for drinking troughs, and therefore the time of year. In the rainy season (from June to November) it is located in the cerril area, in what are the common uses of the commons, during the dry season (December to March) it goes down to the rain-fed farmland, to consume sorghum or corn agricultural wastes and the remaining months (April to May), can be in the agricultural lands or in the producer's corrals where they receive forage or supplements (Figure 2).

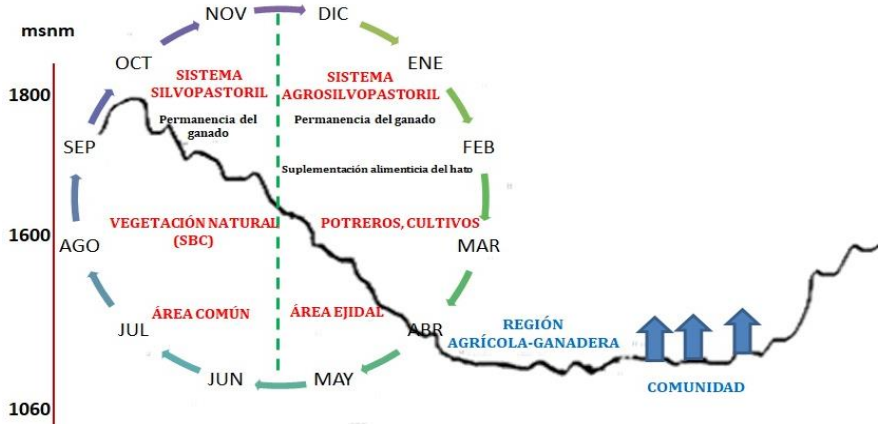

Figure 2. Rotational management and permanence of cattle throughout the year in the different areas of the common of the communities of the Sierra de Huautla (Burgos *et al*., 2016; Uribe *et al*., 2015).

The environmental conditions of the communities of the Sierra de Huautla are contrasting with each other. In order to explain the differences and convey their implications for the ejidatarios and their meanings in agricultural and livestock production, its try to summarize them in three different. The first corresponds to the communities whose location is in the interior of the Mountain range, and therefore, their natural resources, areas to develop productive activities contrast with the rest of the communities. The absence of flat lands is appreciated, the less pronounced hills are used for agriculture with plowing, the lands with vegetal cover are used as pasture land. The communities with this type of exploitation are: El Limón, Los Sauces, El Tepehuaje, San José de Pala, Ajuchitlan, Santiopa, Huautla, Xochipala, Rancho Viejo, among others.

Communities that have a territory that combines steep slopes, hills and flat areas will have less limiting production conditions, since their flat lands will allow the use of irrigation and combine technological advances such as irrigation, improved seeds and pesticides without restriction. In the case of lands with greater slopes, rain-fed agriculture is carried out with restrictions due to high slopes, shallow soils, resulting in marginal agriculture, for self-consumption or with part of the harvest for sale.

In the case of lands with more slopes, their characteristics require silvopastoral use, use of vegetation and minerals. The communities with this type of condition are: Ixtlilco el Grande, Ixtlilco el Chico, Tepalcingo, Pitzotlan, Huitchila, Zacapalco, Chinameca, El Vergel, Santa Cruz, among others. Finally, the third condition corresponds to communities that do not have land within the Sierra de Huautla; however, due to its proximity and given that they do not have hill land, useful for grazing cattle in the rainy season, they make arrangements with communities in the Mountain range and establish sharecropping agreements so that their cattle remain in the pasture lands during the rainy season, in exchange for some payment. The communities with this type of agreement are: Atotonilco, Huitchililla, Tetelilla, Villa de Ayala.

The peasants in general have a fairly developed understanding and know the physical characteristics that tree species have, attributed to empirical evidence, assumptions and beliefs (Muñoz *et al*., 2003). Livestock consume more tree species than herbaceous species, which is why

extensive knowledge about the physiology, adaptation and other ecological and socioeconomic aspects of the various tree species is due to the generation of goods and services, which allows producers to use appropriate in the daily agroforestry (Mosquera, 2010).

Classifying and characterizing species from a biological approach is limited to integrating the perspectives of farmers and this situation led to a distancing between local and external actors, which is why it is important to apply qualitative and quantitative research methods (Pimbert, 1995).

Finally, in the common of Ajuchitlan, Tlalquitenango, Morelos, Burgos *et al*. (2016) defines two types of cultural value (IC) and importance value (VI), with regard to the most important species for their IC, these were *Eysenhardtia polystachia* with 90%, *Mimosa benthamii* with 82%, *Haematoxilum brasiletto* with 68% and *Crescentia alata* with 57%, while the species with the highest VI were: *Mimosa benthamii* with 114% and *Crescentia alata* with 50%, among others.

These species have a use of resin, medicinal, posts, fruits, forage, firewood and living fence, and knowing them can help the construction of projects of agrosilvopastoral systems with farmers (Briñez *et al*., 2016). The importance of these species shows their dominance in the silvopastoral system and affirms the difference of this agroecosystem with the dominance of plant species typical of the SBC.

Conclusions

The current expression of the Rebiosh vegetation is that of a silvopastoral system, different from the expression of the SBC, which has been historically formed in almost five centuries, with cattle being a constant in the exploitation of natural resources that has passed of the extensive cattle ranching, inherited by the Spanish farms, transferred to the large herds in the Porfirian farms, which were destroyed by the Zapatista revolution and at the same time they were their sustenance, and that reappears in the common livestock.

The vegetation of the Rebiosh is not a conserved ecosystem, which was one of the justifications for the creation of the protected natural area, with which neoliberalism opens the door to the commercialization of nature and biodiversity, a strategy in which the owners of the territory (ejidatarios) were not consulted and so few are the beneficiaries. The traditional uses of natural resources are criminalized, they are conditioned to the application of the norm, and with this the community management decisions are reduced to the institutional bureaucracy, which does not serve the users and reduces its decisions to the application of a law.

The high animal load supported by SH can be explained in terms of the use of areas with agricultural waste and the temporary supplementation in the limiting season of forage production, cyclically throughout the year. All expressions of peasant management of livestock that have managed to use natural resources efficiently and are expressed through traditional silvopastoral systems. For this reason, traditional silvopastoral systems must be studied in detail and together with the producers build proposals for their improvement and their inclusion as an alternative to the Rebiosh Management Plan, where the perspective of the users is incorporated.

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