

**THE ROLE OF SOCIAL LINKS ON COMMUNITY RESILIENCE AND DEVELOPMENT:  
The case of Ambaro-Bekibo, Vatovavy Fitovinany Administrative Region - Madagascar**

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**ABSTRACT**

This article analyzes the role of social links on a community resilience and development, the study is presenting the rural community of Ambaro-Bekibo in southeastern coast of Madagascar. From the literature perspective, a resilient community is capable to organize itself so as to be able to overcome the various hazards or disasters which could strike, and then to continue to sustain and improve its daily life as well as its environment by weaving social tie and by focusing more on solidarity.

In Madagascar, this social link known as “fihavanana” is the basis of life in a community. It expresses a relation of alliance between members of an extended family. The fihavanana can play a role of community insurance against risks and constitutes a means for the community to bringing intra-community resources based solutions to its problems which increases its resilience and generally its capabilities leading to the development.

The results of Ambaro-Bekibo case study through the application of an approach based on a non-parametric method of indices, indicate that the community recorded an improvement of its capacities and consequently its resilience thanks to the existing social links such as material and financial mutual aid as well as between individuals within the community. The existence of a functioning community market, community attic, education and health structures, anthropological practices tending to strengthen knowledge and traditional knowledge, as well as environmental protection activities are also listed as significant factors of development of the community.

**KEYWORDS:** social link, community resilience, development, Ambaro-Bekibo, Madagascar

## INTRODUCTION

Since the establishment of the Hyogo Framework for Action (2005 - 2015), resilience has been at the heart of disaster risk management analysis. It is more and more used as a concept to guide practice on risk governance, especially related to climate change and variability and development in general. The concept of societal resilience is increasingly advanced (Hall and Lamont 2013), which can also be equated with community resilience.

In fact, "community" resilience considers the community dimension to be different from all the individuals taken separately. A resilient community is organized in such a way as to be able not only to overcome the various possible catastrophes, but especially to improve its daily life and its environment, especially with regard to the social bond, by focusing more on solidarity. One of the key factors of collective resilience is therefore the existence of a social bond.

In Madagascar, one of the forms of this social bond known as *fihavanana* forms the basis of community life. It defines, in its strictest sense, the bond that unites people of the same blood and in its interpretation; this term expresses a relationship of alliance between members of an "extended" family. It is then the concretization of the relations of solidarity with a heritage, that it takes the form of a territory, common ancestors, shared resources, etc. (Aubert, 1999). Fihavanana, in principle, can play a role in community insurance against risk (Ganon, Sandron 2003, 2005). This form of solidarity is a community for creating solutions to its problems, including the risks of disasters, by relying on its own resources.

The purpose of this paper is to conduct theoretical and empirical reflections that show to what extent the existence of an important social link may be a vector for strengthening the resilience of the entire community to cope to a shock.

Thus, the document has four sections, the first will present the literature review and show that the social link can lead to a form of coordination and constitutes an insurance against the risks within a given community. The second will link the concept of social connection, risk management and resilience. In the third section, we apply this concept of social link to the case of a community located in the eastern part of Madagascar. And finally, we have community resilience assessment through a multidimensional resilience index or MRI.

## Section 1: Theoretical framework: the social cohesion as a Convention and as a Form of Coordination

So far, several ideas expressed by the term of *fihavanana* have been used in the sense of intuitive behavior, referring to a general behavior of solidarity, a consensual norm, based on the concept of kinship (blood and fictional). But in a general way, the *fihavanana* indicates the type of relationship that links relatives (*havana*) in the broad sense and that can be spread to non-relatives whose the neighborhood and friendship are appreciated (Fauroux 2002 148-149). In this sense, it also expresses a precise vision of the group, in which solidarity is expected.

It is worth noting a distinction between a behavior based on kinship (*genealogical fihavanana*) and a behavior based on living together on the same *territory (fihavanana of residence)* . Two variations are to be identified:

(i) All biological descendants standing as parents (and ideally living together) are common ancestors, a unit of life (*aina*). As a product of the same value, they are equal to each other, having the responsibility to support each other;

(ii) The mere fact of living together on a territory itself and of feeding on its resources constitutes a participation in a unit of life, creating a moral obligation to support oneself. These two units of life are still hierarchical: the solidity of those who live in a unit of the family patrimony is considered to be stronger (because it is definitive) than the social link which is from the fact of living on a same territory (Kneiz 2016).

In a set of rules and norms in the sociability network, behavior is at the center of exchange in Malagasy villages and constitutes a standard of coordination at the different levels of Malagasy society. In a series of publications (Gannon and Sandron 2003, 2005, 2006, Sandron 2007, 2008), *fihavanana* has been analyzed as a form of regulation of production and as forms of interpersonal arrangements and relationships that guide economic coordination. economic actors and the social organization of village communities. Their analyzes showed that solidarity, mutual aid and reciprocity are at the heart of *fihavanana* relations. He finds his expression of sharing daily life, communicating and bonding. The trust but also the social control are the founding principles and the mechanisms of regulation of the relations of *fihavanana* (Sandron 2016).

*Fihavanana* is a "special rule that coordinates behavior". Explicitly or implicitly, a large majority of Malagasy refer to it when they gather for family ceremonies (marriage, circumcision, exhumation, burial, etc.) or when self-help mechanisms must be activated (mutual aid, loan of money, self-help for house building etc.). This "spirit of solidarity", "mutual respect", is far from being purely sentimental, it actually

obeys a set of rules of life where the help provided always calls for its counterpart. This local organization, based on strong networks of solidarity and mutual aid, above all makes it possible to ensure the survival of the members of the community and governs their behavior. The *fihavanana* constitutes a real social link within the Malagasy rural communities, it is a set of rules and norms which define a code of good behavior in society.

*Fihavanana* is therefore a convention (Ganon, Sandron 2003). Conventions are rules that are often implicit and always marked by the seal of a certain arbitrariness, in the sense that coordination could have been achieved on another agreement, equally powerful. (Favereau, 1999, p.57). Conventions are common in communities' life and beliefs that are characterized by specific monitoring conditions. The genesis of a convention is often unknown and, if not, the knowledge of its history has no effect on its application. Moreover, compliance with the Convention is not supported by legal sanctions. However, conventions are effective means of coordinating human activities.

The behavior of actors is conditioned by the anticipation of those of others (Colin, 2003). To illustrate this, we denote a pattern of behavior R within a population P such that: (1) all members of the population conform to R; (2) each believes that all the other members of P conform to R and (3) finds in this belief a good and decisive reason for conforming to R; (4) moreover, at least, another regularity verifying the previous conditions could have prevailed (Sugden, 1986, Orléan 2004). The challenge of thinking about conventions is to formulate a framework for analyzing coordination based on the diversity of modes of action. The theory of conventions shares with the works of the new economic sociology the acceptance of the embedding of relations in historical, cultural or social institutions. In addition, because it takes into account politics and stakeholder play in its dynamic approach, it is consistent with theories of strategic behavior. The fundamental characteristics of the convention are thus present: force of the precedent, habit, inertia, secularity, resistance to the mutation, local specificity, mechanisms of deterrence, normativity (Sandron, Ganon, 2003). This notion of normativity is reinforced by Sugden when he characterizes the convention as a social force endowed with autonomy, capable of transforming consciences and behaviors. He goes so far as to recognize that value judgments can lead actors to respect conventions even when it is contrary to their interests. He gives the example of the voluntary production of public goods (Sugden, 1986, 160-1).

## **Section 2: *Fihavanana*, Risk Reduction, Resilience and Development**

Combined with other shocks, disasters of whatever severity or origin, with overlapping effects, can overthrow the development effort and lead to permanent losses in production through the destruction of fixed capital, the reduction of the financial space, the increase of the debt and the erosion of the resilience of the populations. Small economies are particularly vulnerable because they are less diversified and

already subject to greater economic pressures (United Nations Publication Sales, Sales No. E.13.II.F.3). However, these disaster risks can be significantly reduced through strategies and actions that aim to reduce vulnerability and risk exposure, as part of wider efforts to combat poverty and inequality. Resilience is at the heart of disaster risk management analysis and is used as a concept that measures a shock's resistance to a shock and is now a multidisciplinary concept. It can be defined as "the capacity of a system, community or society exposed to risk, to resist, absorb, accommodate and correct the effects of a hazard, in a timely and effectively, including the preservation and restoration of its essential structures and functions. (UNISDR, 2009. p27).

The resilience of a system or community can therefore be understood as: (i) the resilience of a system or community to the mitigation of stress or destructive forces through resistance or adaptation, (ii) the ability to manage or to maintain certain basic functions or structures, during disastrous events; (iii) the ability to recover or "bounce back" after an impact.

But should it also be noted that "resilience" is generally viewed as a broader concept than "capacity" because it goes beyond the specific behavior, strategies and disaster risk reduction measures that normally fall within capacities. Ultimately, it is easily understandable that the resilience in question is about the ability to bounce back, recover or recover from one's own means. On the other hand, some aspects of adaptive capacity and the management of some core functions are more relevant to disaster risk reduction initiatives that involve the development and implementation of policies, strategies and practices, on a large scale, to minimize vulnerabilities and disaster risks in the wider community.

The problem of vulnerability of areas exposed to natural hazards and their ability to cope with shock or disturbance involves multiple disciplines. The multidimensional aspect of resilience makes the definition and correlatively its evaluation as a very complex exercise so that there are several indicators of cascading perception of resilience. Thus, the jurists can deduce from their analysis that if the concept of vulnerability can be reduced to certain weaknesses or particularities concerning an entity, an individual or a group of individuals (children, pregnant women, poorly housed), "Vulnerability linked to natural risks requires no longer focusing on the fragilities of individuals but considering" macro measures concerning the entire area (Sanséverino-Godfrin V., 2009).

As a result, the ambition to reduce vulnerability to natural hazards and increase resilience requires a systemic, global approach to territories. This goal of reducing vulnerability to natural hazards and developing resilience has been hugely appealing to researchers and experts in every continent. It is interesting to note that almost all authors refer to the need to treat the issue in a systemic way by considering the maximum of variables or indicators to measure the resilience of a group or community.

As a result, the measurement of resilience has been the subject of serious initiatives that have dealt with either general systems, regions, cities, or more or less restricted communities. Twigg J. and Benson C. (2004, 2007) are among the first to have proposed a methodology for assessing resilience with both quantitative and qualitative performance indicators for an ideal state of resilience. They have provided a guidance note for development agencies. It is interesting to note that despite the blossoming of definitions of resilience, common elements mention the ability to absorb shocks, the ability to adapt to a changing environment, and the ability to transform the institutional environment.

Among other things, the Index<sup>1</sup> of Measurement and Analysis of Resilience, which was initiated by FAO, is based on a list of contextual factors that make a household resilient to food security crises. In addition, Kyoto University with the Climate Disaster Resilience Initiative (CDRI) has developed the most resilience indices with the collaboration of international partners in addressing the physical, social, economic, institutional and natural dimensions. The initiative resulted in the creation of resilience profiles for cities vulnerable to natural hazards: 15 Asian cities in 2009. Curiously, the development of a resilience index could be applied to very specific needs such as the case of Moteff (2012) for security infrastructure in the United States, the index he imagined is supposed to improve decision-making in strategic security contexts.

In the resilience building strategy, groups or households can cope with "non-erosive" strategies that do not affect their livelihoods for the future. In this vision, the *fihavanana* plays a very important role in developing the resilience of a community. Indeed, as mentioned in the previous section, the *fihavanana* is a system of rules, norms and customs that govern the dynamics of the local society, enact interpersonal behaviors, modes of sociability and anti-risk strategies (Sandron 2008). Guided by this shared value, mutual help was spontaneously exercised in many areas and in many circumstances. In this social contract, some were linked to others (Rabemananjara 2001, Sandron 2008) and this leads to a set of organizational and insurance mechanisms that allow the survival of members of village communities (Sandron, 2008).

By regulating at least part of the social and economic life of the peasants, "*fihavanana*" can be interpreted as an instrument of reduction, global and community risk management. In addition, the alliance systems created by the *fihavanana* can be improved the capacity that is to say the resilience to see a development in a community.

### **Section 3: Ambarobekibo Rural Community: a case study of *fihavanana*, Resilience and Risk Management**

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<sup>1</sup>Resilience Index Measurement and Analysis, (RIMA-II), FAO 2016.

To analyze the importance of *fihavanana* and its link in resilience analysis and risk management in the community under study, we conducted qualitative thematic interviews and quantitative surveys that were then combined with a review of the literature on the area studied.

The results of the quantitative approach will be developed in the section on the Multidimensional Resiliency Index (RMI) study later. On the other hand, the part that we will analyze below relates the results of the free discussions in the form of group focus or discussions with resource persons of the community. The latter methods of information collections were chosen in order to obtain diverse but complementary information on the subjects treated including *fihavanana*, resilience and development. This method was also adopted to deepen, verify or even improve the trends of ideas from the literature. Thus, in the discussion groups, there are different categories of people like president of the youth, members of CLGRC<sup>2</sup>, nurse, members of the CCGRC<sup>3</sup>, leader farmers, and simple members of the community. It should be noted in passing that the reference point of this study is the flooding shock following the passage of Hurricane Chedza in February 2015.

### ***3.1. Manifestation of the social bond in the locality of Ambaro Bekibo***

The community we are studying to analyze the importance of social link in the development of resilience is Ambarobekibo. It is among the eight Fokontany<sup>4</sup> which constitute the rural city of Ankatafana, in the district of Mananjary, in the Vatovavy Fitovinany administrative region, located in the Southeast part of Madagascar. Crossing the National Road No. 7, Mananjary is about 528 km from Antananarivo, the capital of Madagascar.

The inhabitants of Ambarobekibo are Antambahoaka, from Mananjary, and Antemoro, migrants from the northeastern part of Vatovavy Fitovinany region. The economic activity of the population is based on agriculture and fishing. But in general, the livelihood base of the population is agriculture. The rice crop (in a traditional way) dominates, and the farmers practice it in two seasons: "vary vatomandry"<sup>5</sup>,

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<sup>2</sup> Local Committee for Disaster Risk Management.

<sup>3</sup> Communal Committee for Disaster Risk Management.

<sup>4</sup> The Fokontany is a basic administrative subdivision at the commune level. The Fokontany, according to the importance of the agglomerations, includes hamlets, villages, sectors or districts. The inhabitants of Fokontany constitute the "Fokonolona" (Art 2 of the Decree N ° 2004-299 of March 3, 2004 fixing the organization, the functioning and the attributions of the Fokontany).

<sup>5</sup> Vary vatomandry: rainy season rice, beginning of harvest in May.

"varyhoso"<sup>6</sup> then the "vary an-tanety" or the rain rice. On the other hand, other crops exist, namely cash crops and legumes, but to a lesser degree. On the social level, some values still hold their place in the community. And *fihavanana* is one of them.

Different authors (F.Gannon, F.Sandron, 2003) see in *fihavanana* the quality of regulator of the social relations. Considered conservative of this Malagasy cultural value, the community of Ambarobekibo still weaves some tangible social connection because community solidarity is still palpable in various fields both from the economic point of view and from the social point of view (F.Gannon, F. Sandron, 2006). The principle of mutual support and regulation of the social relationship of the *fihavanana* is still maintained. This situation is due to the fact that the role of the Ampanjaka (King) as guarantor of the traditional culture (including the *fihavanana*) of society is not yet gone. Thus, the authority of the latter continues to govern the community and its power still exists especially in the socio-cultural field. Despite the modern administrative system and the invasion of external practices and cultures, the establishment of new organizations and the success of interventions in the community do not find their anchor without the blessing of traditional authority (P. KNEITZ , 2016).

From this point of view, not only is *Fihavanana* a convention to the extent that the community agrees to respect the existing organizational system under the auspices of the Ampanjaka. Thus, its role in the regulation of social relations is not left out.

Regarding the practice of aid, it is not very prominent in Ambarobekibo in the agricultural sector as usual. It is tangible in services such as housing. This situation is not surprising since part of the economy of this community is dominated by fishing and a large part of the land occupants are not legal owners, especially for cash crops. However, this feeling of non-ownership often constitutes a blocking factor for farmers in the development of their agricultural investments that sometimes require enough volume of factors of production such as labor. On the other hand, food crop farmers use only sufficient land for their own needs. They do not need other labor forces.

On the other hand, the case is not similar in construction works where mutual assistance is present. Thus, in housing and the construction of a new hut, the owner is responsible for buying the wood that will form the frame of the house. Then it is the community that builds together bringing the local materials needed for construction like *raty*, *falafa*. In addition, each man owes 100 Ariary<sup>7</sup> for construction.

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<sup>6</sup> Vary hoso: dry season rice, beginning of harvest in December.

<sup>7</sup> One dollar equals three thousand and five hundred ariary on march 2021.



Seen in this light, there is a tendency to think that mutual aid is maintained mainly on occasional circumstances. In our case, it is essentially in construction that mutual support manifests itself. However, the arrival of the monetary transaction gave another form of mutual aid without having abandoned it. Indeed, in the field of health, because of the *fihavanana*, the payment of the consultation fee as well as the medicines can be credited to the patients of the community of Ambarobekibo. The refund will be made during the harvest period. Thus, besides the social aspect of mutual aid, its manifestation in the financial field is not unimportant in the two cases mentioned above.

### ***3.2. Community social organization as a form of fihavanana, risk reduction and contribution to resilience***

As mentioned in section 2 above, *fihavanana* can play a role in community risk insurance and is a way for the community to find solutions to its problems. Risk management activities in Ambarobekibo were mainly under the umbrella of the NGO Partner<sup>8</sup>. This intervention dates back to 2009. But note that the effectiveness of the actions carried out generally depends on the involvement of the community during all processes. For the most part, actions are necessarily focused on training and capacity building. But some infrastructure work has been done as well. If the partner provides training and mentoring to a local RCMP committee so that they can sensitize the community, it is the community that in turn appoints the committee members. Thus, given the place still held by this community structure led by a traditional Authority, the *fihavanana* has its footprint in managing and reducing disaster risk. Indeed, the Local Committee for Risk and Disaster Management (CLGRC) is a new structure and organization introduced for the RCMP, and the involvement of the community in its implementation is recognized and not negligible.

Consider the case of the construction process cited in *supra* during which the intervention of the community is still actively observed and the footprint of the CLGRC is seen. In fact, despite the fact that cutting tree trunks for the purpose of fortifying the house is among the local practices of the community, the CLGRC is in turn responsible for raising the awareness of households of everything that revolves around protection and strengthening of homes. These measures are taken in the context of disaster risk reduction. This is also the case for the local practices and practices of parking the dugout canoes as close to the house as possible to prepare for the flooding as well as the building of houses with round woods to prevent the winds.

Note in passing the local practice adopted in the construction of the community shelter in case of flood risk during which it was the community that provided the necessary local materials. In addition, although

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<sup>8</sup> The SAF FJKM.

this construction was not yet taking place, a community member on behalf of *fihavanana* offered a place to provide shelter for the community when needed.

Note also the public knowledge of the color code process and its meanings. The awareness created by CLGRC is a cause, but the fact that the community is grouped in a single hamlet and under the aegis of the respected traditional authority also explains it.

In addition, the community's respect for signs that are considered common property in the event of disaster risks further illustrates the mutual consideration of the Ambarobekibo community. Thus, this consideration becomes a value and factor of security for the entire community.

Moreover, the life of the Ambarobekibo community is characterized by the promiscuity of two cultures or two different organizational systems: one based on tradition, custom and custom and the other on practices from outside the community. society and the community. On the other hand, the cohabitation of these two cultures is not a blocking factor in the organization of community life in Ambarobekibo, complementarity is rather appropriate. Indeed, if traditional value is considered as the basis for the organization of community life in all areas, the added values brought or arrived from outside contribute to strengthening the capacity of the community in some cases to cope to the effects of hazards. In the case of the Ambarobekibo Fokontany, the intervention of the partners focuses mainly on capacity building such as training and sensitization, but works on infrastructure (agricultural and social) also exist. On the other hand, the success and results of this intervention depend, of course, on the community's support for the actions undertaken. This is how *fihavanana* plays an important role in that, in addition to the traditional knowledge and practices that allow communities to prepare for, cope with and rise to the shocks of hazards, its character as a regulator of social relations and community solidarity factor facilitates the involvement of all in risk management processes whether before, during or after the shock.

#### **Section 4: Analysis of *Fihavanana* contribution to the resilience of the Ambarobekibo community: The Multidimensional Resilience Index Approach**

This is to assess the implications of *fihavanana* (social link) on the resilience level of a local community in a developing country after the occurrence of meteorological disasters, including cyclone and flood, etc. For this, we have initiated a non-parametric approach highlighting the methodological approach to establish a multidimensional index of resilience (MRI), which is calculated at the level of the study community and considering the factors of social link. Primarily, the approach is divided into two parts: (i) the first focuses on the method of developing the Multidimensional Resilience Index (MRI) itself; (ii) and the second part highlights the process of estimating the time needed for the community to resume its structures before the disaster, thus leading to resilience.

**4.1. Methodological approach and tools**

As the study of resilience is not confined to a single domain but requires the opposite to several fields of analysis (economic, legal, infrastructural, sociological, etc.), it is often difficult to measure, observe and especially quantify it directly. In addition, given the need for the various actors to design, implement, monitor and evaluate more effectively the capacity building of populations and communities most at risk in order to prevent them or to mitigate, it is essential to have information on the number of resilient households and their degree of resilience in the community.

In sum, the Multidimensional Index of Resilience has a fairly simple mathematical construction. It is measured by a weighted arithmetic average of the basic indices that are calculated from the variables (see Annex 1) that have been selected by considering the multidimensional aspect of resilience. Thus, for the calculation of resilience, the basic variables are grouped into a set of indicators that are themselves grouped into a set of criteria (economic, social, cultural, institutional, organizational, environmental and capacity building). We can see in the following table the structure of the variables and indicators of the economic criterion considered for the calculation of the Multidimensional Resilience Index.

*Table 1: Variables and indicators of the economic criterion of the MRI*

<i>Criterion (z)</i>	<i>Indicator (y)</i>	<i>Variable (x)</i>
<i>Economic</i>	<i>1- Household income (living conditions)</i>	<i>Number of daily meals</i>
		<i>Quality of daily meals</i>
		<i>Activities contributing to the well-being of the household</i>
	<i>2 - Number of Income Generating Activities (IGA) per household</i>	<i>Number of IGAs exercised per household for the whole of IGA</i>
	<i>3 – Production</i>	<i>Agricultural Production: (improvement of crop yields)</i>
		<i>Breeding: (improved performance of breeding activities)</i>
		<i>Fishing: (improvement of fishing performance)</i>
		<i>Crafts: (performance improvement of craft activities)</i>
		<i>Services: (performance improvement of service activities)</i>

Source: Auteurs.

The construction of the MRI presents two (2) important transformations, extremal values and thresholds and a weighting that will be progressively clarified in this document. The first transformation is the one leading to the basic indices, and the second is the use of the decimal logarithm. It should be noted that the first transformation is based on the improved method of calculating the Human Development Index (HDI) used by the United Nations Development Program until 2009. Moreover, since the Multidimensional Resilience Index considers various parameters whose weights differ, thus showing the divergence of their contributions, the model used the methods of data analysis, in this case the Principal Component Analysis (PCA) by the predominantly quantitative aspect of the parameters.

Therefore, for the sake of manipulation and easy adaptation of MRI to the realities of a structure, and specifically a community of a developing country, the approach and calculation method of this Index will be established simple for easy application but will also be specific in that the weights used will be determined using universal statistical and scientific methods.

## ▪ MRI development method

The Multidimensional Resilience Index is cascading as it is gradually being built. First, since the variables are expressed in various units of measure (meter, %, etc.), we transform the different variables into indices called "basic indices" which are thus calculated and obtained at the level of the variables. Then, new indices are calculated at the indicator level by considering the basic indices and the weights estimated from the Principal Components Analysis (PCA). Then, the indices at the level of criteria (economic, social, cultural, institutional, organizational, environmental and capacity building) are also calculated by taking into account the indices previously calculated at the indicator level. Finally, the Multidimensional Resiliency Index is calculated by calculating the weighted arithmetic mean of the indices calculated at the criterion level.

### ➤ *At the variable level:*

For each of the qualitative variables ( $X_i$ ), calculated as a percentage or proportion, a basic index is determined according to the formula:

$$Index(X_i) = \frac{(X_i) - \min(X_i)}{\max(X_i) - \min(X_i)} \quad (1)$$

For each of the quantitative variables ( $X_i$ ) that express an amount or a number, we also determine a base index but taking the logarithms decimal values indicated:

$$Index(X_i) = \frac{\ln(X_i) - \ln \min(X_i)}{\ln \max(X_i) - \ln \min(X_i)} \quad (2)$$

Also, it should be noted that the value 1-Index (Xi) measures the lack for a household or a community in the criterion corresponding to the variable Xi.

The expression of equations (1) and (2) reveals the concern to take all the variables in relative value, so as to make them in the same unit of value and to calibrate their values between "zero" and "one". Therefore, for a given community or household, the highest deficiency in a criterion leads to a null index, and a maximum resilience level to the unit value.

In addition, the use of logarithm rather than raw value or number in the calculation of the index associated with certain variables is based on the assumption of marginal utility decay. This hypothesis makes it possible to estimate the decreasing marginal contribution of these variables expressing the social cohesion (Fihavanana) to develop the capacities and thus to generate the resilience of the community.

For example, Log (Number of daily meals) is similar to the basic need of the household to consume, which is a form of use of their income. Consumption provides utility to the household, and the number of daily meals serves only by the "utility - resilience" it provides.

However, to better understand the idea of decaying the "marginal contribution to resilience", the Atkinson income (y) utility formula (w) should be examined:

$$w(y) = \frac{1}{1 - \varepsilon} * y^{1-\varepsilon} \quad (3)$$

The parameter  $\varepsilon$  represents the elasticity of the marginal utility of income. It expresses the decreasing return on income. If  $\varepsilon = 0$  there is no decreasing return, whereas a value of  $\varepsilon$  approaching the unit symbolizes a sharp decrease in the marginal return. On the other hand, when  $\varepsilon$  tends to 1, equation (3) becomes:  $w(y) = \text{Log}(y)$ . Therefore, the use of Log supports the desire or idea of a maximum decrease in the marginal contribution of certain variables or parameters to resilience.

➤ *At the indicator level:*

For each indicator, an index is also calculated. This index is determined by a weighted average of the values of the basic indices calculated at the level of the variables. Since there is no uniformity of weights,

because of the differences in the ranges of the ranges of the variables and the use of the Log, it is necessary to determine coefficients reflecting the importance of the parameters which should be able to reflect the actual weights of these (or the contribution of each parameter) in the Multidimensional Resilience Index.

The methods of data analysis make it possible to optimize the weightings to be applied to the different variables (Tatlidil, 1992). Specifically, given the characteristics of the data that would be obtained with the variables (mainly quantitative data), the application of the Principal Component Analysis (PCA) will be used to determine the weighting for each variable. For this, the analysis variables considered are the variables or the basic parameters.

After applying the PCA, if the main eigenvalue explains more than 60% of the inertia, we take only the main corresponding factorial axis (the first factorial axis) and the weighting factor coefficients associated with the different variables. But in the case where the principal eigenvalue explains less than 60% of the inertia, it will be necessary to take all the factorial axes until one obtains 60% of the inertia and by making the sum of each coefficient of each variable for each axis factorial, we will obtain the weighting coefficient of each variable.

The weight assigned to each variable or parameter is determined as follows:

- we take the coordinates of each variable to the factorial axis (its correlations to the factorial axis),
- we calculate the total sum of all the coordinates,
- we make the ratio between the coordinates of each variable and the total sum of the coordinates and we thus obtain the weighting for each variable.

As mentioned above, for each indicator, an index is calculated by taking a weighted average of the indices calculated at the level of each variable by applying the weighting of each variable.

$$Iy_i = \frac{1}{\alpha} \sum_{i=1}^k \alpha_i Ix_i \quad (4)$$

$$\text{So: } \alpha = \sum_{i=1}^k \alpha_i \quad (5)$$

$k \in [1, i]$   $Iy_i$ : Index at the indicator level and  $Ix_i$  : Index at the variable level

For example: Index at the indicator level:

$$\text{Household Income Index}^9 = \frac{1}{\alpha} [\alpha_1 (\text{Index-Number of daily meals}) + \alpha_2 (\text{Daily Meal Quality Index}) + \alpha_3 (\text{Index-Activities contributing to household well-being})]$$

$$\alpha = (\alpha_1 + \alpha_2 + \alpha_3)$$

$\alpha_1$ : Weighting calculated by PCA of the variable "Number of daily meals".

$\alpha_2$  : Weighting calculated by PCR of the variable "Quality of daily meals"

$\alpha_3$  : Weighting calculated by PCA of the variable "Activities contributing to the well-being of the household"

➤ **At the criteria level**

For each criterion, an index is also calculated by performing a weighted average of the indexes calculated at the indicator level.

So:

$$I_{z_i} = \frac{1}{\beta} \sum_{i=1}^k \beta_i I_{y_i} \tag{6}$$

$$\text{Avec } \beta = \sum_{i=1}^k \beta_i \tag{7}$$

$k \in [1, i]$   $I_{z_i}$ : Criteria index and  $I_{y_i}$ : indicator index

For example: Criterion level index:

$$\text{Economic Criteria Index} = \frac{1}{\beta} [\beta_1 (\text{Household Income Index}) + \beta_2 (\text{Index-Number of Income Generating Activities (IGA) per household}) + \beta_3 (\text{Production Index})]$$

$$\beta = (\beta_1 + \beta_2 + \beta_3)$$

$\beta_1$  : Weighting of the Household Income Index

$\beta_2$  : Weighting of the Index-Number of Income Generating Activities (IGA) per household

$\beta_3$  : Weighting of the Production Index

<sup>9</sup> Cf. Annexe 1.

➤ *The Multidimensional Resilience Index (MRI)*

$$MRI = \frac{1}{\delta} \sum_{i=1}^k \delta_i I_{z_i} \quad (8)$$

$$\text{With } \delta = \sum_{i=1}^k \delta_i \quad (9)$$

$k \in [1, i]$   $I_{z_i}$ : Criterion index

For example:

$MDI = \frac{1}{\delta} [\delta_1 (\text{economic criterion index}) + \delta_2 (\text{social criterion index}) + \delta_3 (\text{cultural criterion index}) + \delta_4 (\text{institutional criterion index}) + \delta_5 (\text{organizational criterion index}) + \delta_6 (\text{environmental criterion index}) + \delta_7 (\text{Criterion for capacity building})]$

$$\delta = (\delta_1 + \delta_2 + \delta_3 + \delta_4 + \delta_5 + \delta_6 + \delta_7)$$

For example:

Multidimensional Index of Resilience =  $\frac{1}{\delta} [\delta_1 (\text{Economic Criterion Index}) + \delta_2 (\text{Social Criterion Index}) + \delta_3 (\text{Cultural Criterion Index}) + \delta_4 (\text{Institutional Criterion Index}) + \delta_5 (\text{Organizational Criterion Index}) + \delta_6 (\text{Environmental Criterion Index}) + \delta_7 (\text{Capacity Building Criterion index})]$

$$\delta = (\delta_1 + \delta_2 + \delta_3 + \delta_4 + \delta_5 + \delta_6 + \delta_7)$$

$\delta_1$ : Weighting of the Economic Criterion Index

$\delta_2$ : Weighting of the Social Criterion Index

$\delta_3$ : Weighting of the Cultural Criterion Index

$\delta_4$ : Weighting of the Institutional Criterion Index

$\delta_5$ : Weighting of the Organizational Criterion Index

$\delta_6$ : Weighting of the Environmental Criterion Index

$\delta_7$ : Weighting of the Capacity Building Criterion Index



It is important to note that these various indices are calculated systematically before shock (before catastrophe) and, if necessary, after shock (after disaster).

➤ Resilience indices value analysis plan

After the process of processing the collected data and calculating the successive indices, the indices between the values 0 and 1 can be represented in the form of heptagon radar charts representing the seven resilience criteria. The radar will show "scores" of 0 to 5, representing the level of resilience of the community. The scores are directly related to the results of the indices calculated for each criterion. The choice of the use of the scores was adopted in order to facilitate the reading and the interpretation of the indices obtained. The following table shows the correspondence and significance of the index results (rounded to two decimal places) and the scores.

Table 1: Matching Indices and Scores

Index value	Score	Level of Resilience	Result
[0.00 – 0.09]	0	Without resilience	Extremely bad result
[0.10 – 0.25]	1	Highly non-resilient	Very poor result
[0.26 – 0.45]	2	Moderate Resilience	Wrong but relatively acceptable result
[0.46 – 0.59]	3	Mean Resilience	Result considered acceptable
[0.60 – 0.89]	4	Good resilience	Good result
[0.90 – 1.00]	5	Very good resilience	Very good result

Source: Authors.

Analysis of the scores:

"0": This score means "zero resilience" in the community after the shock. This demonstrates the inefficiency or inadequacy, or even lack, of the effect of social link on resilience. "1": This score corresponds to a result considered as very bad even if it exists. It means that the community is not highly resilient or existing fihavanana practices are insufficient and do not provide the resilience of the community or the fihavanana practices are almost nonexistent.

"2": Here, the score corresponds to a moderate resilience thanks to the social bond (fihavanana).

"3": This is a score that corresponds to an already acceptable result that can be assessed positively on the resilience of the community. It should be noted, however, that this result can be further improved by strengthening the social bond within the community.

"4": This score corresponds to a result judged as good where the resilience of the community has already reached a satisfactory level. The fact remains that the maximum result has not yet been reached and that there is still the possibility of improving the score obtained thanks to the targeted strengthening of certain activities related to fihavanana and also to the way in which they must be implemented.

5": this is the maximum score meaning a very satisfactory result with a very high level of community resilience, so very good. Since perfection does not exist, there is always the possibility of improving this result, which should result in an improvement in the state or standard of living, for example, of the community, taking into account the characteristics of hazards and climate change.

▪ **Resilience time calculation method**

This second part of the methodological approach highlights the method of calculating the time that the community needs to regain the level of capacity it had before the disaster by its own means. It is simply a question of calculating an index at the level of each criterion which takes into account the temporal dimension. This new index category is calculated as follows:

$$\text{Criterion index with the temporal dimension} = \frac{I_{i,\text{aftershock}}}{I_{i,\text{before shock}}} \left[ 1 - \frac{\ln t_i}{\ln t} \right]$$

With:

- $t_i$ : is the recovery average time of the community in a criterion considered
- $t$ : is the optimal recovery time considered in the community expressing the threshold of resilience. And we assume that  $t$  is equal to 5 months<sup>10</sup> for the economic criterion; and 4 months respectively for the social and organizational criteria; and 3 months respectively for the cultural, institutional, environmental and capacity building criteria.

Also, it will be necessary to emphasize that if the value of the index of resilience at the criterion level before consideration time exceeds 0,90, in this case, the value of the index at the criterion level with consideration time corresponding can be higher than 1. In this case, we assume that for a final index (with time consideration) having a value greater than 1, the latter will have a value equal to 1. This will not generate any bias because the level of the index of Resilience exceeding 0.90 means that the household or

<sup>10</sup> This 5-month resilience or recovery hypothesis is based on the fact that in the economic criterion, the community can normally recover after the shock during a cropping season with an average duration for food crops, particularly rice. 5 months. Because the community should at least recover the level of its pre-shock abilities during a cropping season.

community in question has a very high level of resilience, so it has a very high final resilience index (with time consideration) and therefore recovery time will be close to 0.

**4.2. Results and analysis**

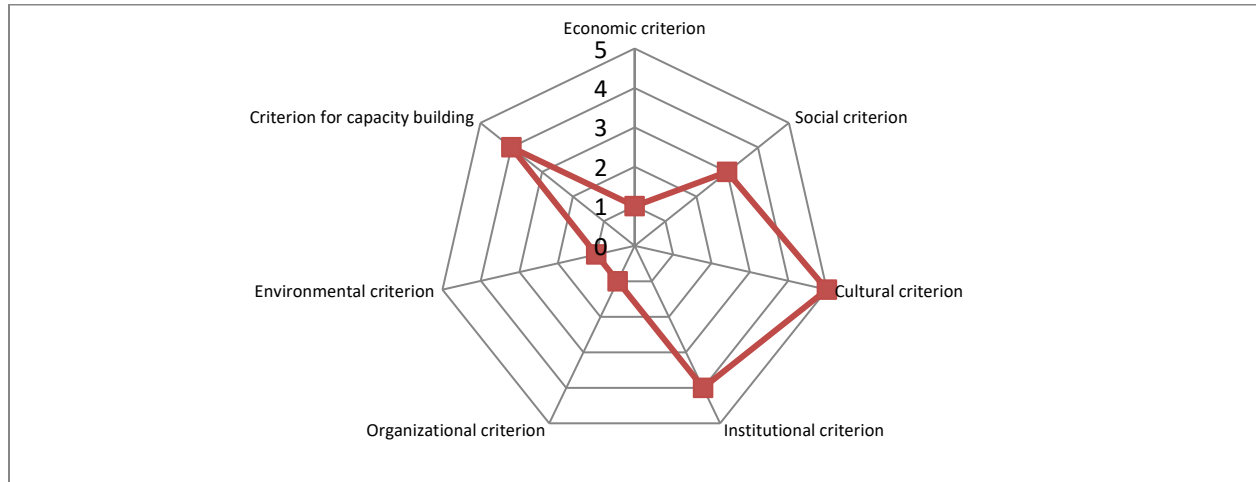
The results of the Multidimensional Resilience Index show a score of 2 expressing a moderate degree of resilience of the Ambarobekibo community after the flood disasters they faced after Tropical Storm Chedza passed through 2015 (see Table 3). These results mean that the community has managed somehow to recover and regain the level of its resources and capabilities generally prior to the onset of the flood.

**Table 2: Results of the Multidimensional Resilience Index for the case of Ambarobekibo community**

Multidimensional Resilience Index (MRI)

2  
Moderate Resilience  
**0,403201857**

N°	INDICATORS	Résultats	Score	Signification
1	Economic criterion	0,116	1	Highly non resilient
2	Social criterion	0,531	3	Mean resilience
3	Cultural criterion	1,000	5	Very good resilience
4	Institutional criterion	0,666	4	Good resilience
5	Organizational criterion	0,206	1	Highly non resilient
6	Environmental criterion	0,197	1	Highly non resilient
7	Criterion for capacity building	0,610	4	Good resilience



Source: Authors.

The overall score recorded does not show a satisfactory result since it can still be greatly improved in order to reach the maximum score of 5. This means that certain aspects or parameters of the social link that should logically work in the community do not occur especially during the flood period. Indeed, either these parameters have not simply influenced the resilience of the community, or they express an indirect link with the *fihavanana*. Moreover, it should be recalled that the MRI is a weighted average of the indices obtained from the various criteria with different weightings which can, consequently, influence the level of the overall result, expressed by the MRI score.

In fact, the results show that four criteria express an acceptable resilience score, namely: a very good resilience for the cultural criterion, a good resilience for the institutional criterion and the criterion of capacity building, and finally an average resilience of the community for the social criterion. However, scores expressing low resilience levels showing highly non-resilient community outcomes are recorded in the remaining 3 criteria which usually consist of variables often indirectly related to the *fihavanana*, these are respectively economic, organizational and environmental.

In the social criterion, despite the maximum value of 5 obtained respectively by the two variables namely "health" and "education", the overall score of the criterion is only of value 3. The two other variables namely "wash" and "Employment" obtained respectively the values 1 and zero. The score equal to 5 of the variable "Health" means that in rural Malagasy communities, access to especially traditional medicines is ensured by learning to produce these drugs which is carried out from generation to generation by word of mouth within family or by consulting a practitioner of traditional medicines in the community. And this access to especially traditional medicines is reinforced by the community during the advent of disasters like the case of flood in Ambarobekibo. The variable "Education" which represents access to children's

education services also scored 5 since classrooms are often built in a common<sup>11</sup> way by the community (FRAM) and teachers are generally individuals who are more or less educated<sup>12</sup> and identified in the community as teachers (FRAM teacher) whose choice is established because of *fihavanana*, particularly in the occurrence of a flood disaster that further amplifies the isolation of flooded areas.

As for the variable "WASH" which reflects access to drinking water and sanitation services, the score obtained equal to 1 shows that wells or standpipes are often the work of the whole of the community. community and their level of achievement, which is not satisfactory in the present case of Ambarobekibo, depends on the degree of participation of community members, particularly following the sensitization carried out by the local committee for disaster risk management. Many efforts must be made to activate the Ambarobekibo community to improve access to drinking water and sanitation services because the existing social link (*fihavanana*) does not lead to results. satisfactory in the WASH sector.

For the cultural criterion, the variable considered, which obtained the maximum score of 5, is traditional knowledge and knowledge. Indeed, the community is rich in traditional knowledge of disaster risk management and reduction. Indeed, under the aegis of the CLGRC<sup>13</sup> whose members are selected by the community, traditional knowledge has been capitalized and popularized with the community so that the latter can prepare for and cope with hazards and disasters. In other words, the cultural characteristics of the community have contributed significantly to its resilience in particular to flood shocks, thus explaining this very satisfactory level of the score obtained.

In the case of the institutional criterion, two variables are considered and share the same score 4, that is, good resilience: customary rights and practices, governance.

As previously mentioned, community-based aid is part of customary practices that continue to exist in the community of Ambarobekibo. In fact, still present in certain activities, such as housing construction work, this practice allows the community not only to protect the social value and maintain the already existing social links. This helps strengthen and improve the community's capacity to prepare for and cope with risks. Regarding governance, the existence of the CLGRC structure that provides awareness and outreach as well as the implementation of Malagasy Red Cross strategies and measures is a great asset to the

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<sup>11</sup> in the majority of the rural enclaves of Madagascar.

<sup>12</sup> Having only the BEPC (Secondary school Certificate) and often not having received a pedagogical training because the legitimate teachers, agents civil servants of the State are almost absent and do not join their post.

<sup>13</sup> Local community disaster risk management unit

community.

### 4.3. Discussions

In short, the social bond is known as the "*fihavanana*" in Madagascar. The *fihavanana* constitutes a real social link within the Malagasy rural communities, it is a set of rules and norms which define a code of good behavior in society. A large majority of Malagasy people refer to it when they gather for family ceremonies (marriage, circumcision, exhumation, burial, etc.) or when self-help mechanisms must be activated (mutual aid, loan of money, mutual aid for house construction etc.). This local organization, based on strong networks of solidarity and mutual aid, above all makes it possible to ensure the survival of the members of the community and governs their behavior. The *fihavanana* can therefore play a role of community insurance against risk and is therefore a way for the community to create solutions to its problems, including damage caused by disasters. The community can rely on its own resources to anticipate, cope and resist and recover from the onset of a disaster.

In fact, a resilient community is organized in such a way as to be able not only to overcome the various possible catastrophes, but especially to improve its daily life and its environment, in particular by weaving social bonds, by placing more emphasis on solidarity. One of the key factors of collective resilience is therefore the existence of a social bond.

The case study of the rural community of Ambarobekibo in the southeastern part of Madagascar reveals that it recorded a score of 2 according to the Multidimensional Resilience Index. The community thus expresses a moderate degree of resilience to the flood disasters it faced after Tropical Storm Chedza passed through in 2015. These results mean that the community has managed to recover level of its resources and capabilities generally prior to the onset of the flood. This means that some aspects or parameters of the social link that should logically work in the community have not operated during the flood period or these parameters have not simply influenced the resilience of the community because they express an indirect link with the *fihavanana*.

In addition, these results underlie the evidence that the level of resilience of a community exposed to any risk changes according to the vulnerabilities and characteristics of the corresponding shocks.

- Improving community capacity in variables that are not directly related to *Fihavanana* (such as those in the economic or organizational criterion) may increase the overall community resilience score at Ambarobekibo.
- Improving community life through strengthening social links in farms or other economic and organizational or environmental activities can demonstrate a link between resilience and development.

For the last criterion, capacity building, he obtained the score of value 4, that is to say of good resilience. These variables namely awareness, extension, simulation exercise have a score of at least value 3. This situation is not surprising since it is the CLGRC members, elected by the community and having the confidence of the latter, which provide this reinforcement. For this purpose, the transmission of messages is easy thanks to the links between the community and CLGRC members.

In the economic criterion the zero value of the variable "AGR" strongly influenced the low value. Indeed, the practice of IGA requires an important social link at the level of awareness and for the use of labor available for agricultural activities in rural areas.

For the organizational criterion, the absence of a coordinating structure and mechanism as well as the early warning system handicap the community studied in their strengthening of resilience. And finally, for a community subject to frequent climatic hazards, environmental protection activities play important roles, while the latter were not sufficiently developed in the community studied.

Thus, despite the contributions of the four criteria (cultural, institutional, capacity building, and social) with variables directly related to the social link and which positively contributed to the resilience of the community, the influences of the other three criteria mentioned above show modest results certainly helped to push down the result obtained from MRI. In addition, these results underlie the evidence that the level of resilience of a community exposed to any risk changes according to the vulnerabilities and characteristics of the corresponding shocks.

## CONCLUSION

The *fihavanana* is a real social link within rural Malagasy communities. It is a set of rules and standards that define a code of good conduct in society. The *fihavanana* can therefore play a role of community insurance against risk and is therefore a way for the community to create solutions to its problems, including damage caused by disasters. The community can rely on its own resources to anticipate, cope and resist and recover from the onset of a disaster. Thus, a resilient community is organized in such a way as to be able not only to overcome the various possible catastrophes, but especially to improve its daily life and its environment, in particular by weaving the social bond, by focusing more on solidarity. One of the key factors of collective resilience is therefore the existence of a social bond.

The case study of the rural community of Ambarobekibo in the southeastern part of Madagascar reveals that it recorded a score of 2 according to the Multidimensional Resilience Index. The overall score recorded does not show a satisfactory result as it can still be greatly improved in order to reach the

maximum score of 5. The community thus expresses a moderate degree of resilience in the face of the flood disasters that it has had to face after the Tropical Storm Chedza passed through in 2015. As a result, the community has managed to recover and regain the level of its resources and capabilities generally prior to the onset of the flood.

It turns out then that strengthening coalition or cooperation and even alliances within the community could improve potential outcomes on the degree of resilience. In addition, improving community capacity in variables that are not directly related to *fihavanana*, such as those in the economic or organizational criterion, can improve the overall community resilience score at Ambarobekibo. In addition, the improvement of community life through the strengthening of social links in the economic (farm or other) and organizational or environmental criteria can prove the link between resilience and development.

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**Appendix:**

*List of criteria, indicators and variables for calculating the Multidimensional Resilience Index*

Indicator (y)	Variable (x)	Score	Result (Index)
<b>economic criterion</b>		<b>Score</b>	<b>Index</b>
1- Household income (living conditions)	Number of daily meals	3	0,56819976
	Quality of daily meals		
	Activities contributing to the well-being of the household		
2 - Number of Income Generating Activities (IGAs) per household	Number of IGAs exercised per household for the whole of IGAs	0	0,0385323
3 – Production	Agricultural Production: (improvement of crop yields)	1	0,11699211
	Breeding: (improved performance of breeding activities)		
	Fishing: (improvement of fishing performance)		
	Crafts: (performance improvement of craft activities)		
	Services: (performance improvement of service activities)		
<b>social criterion</b>		<b>Score</b>	<b>Index</b>
1 – Health	Access to particularly traditional medicines thanks to exchanges within the community	5	0,910611
2 - Education	Access to education services (classrooms built by the community, FRAM teachers paid by the community)	5	1
3 - Employment	Self-employment (Number of self-employment jobs created in the household)	0	0,189074
	Salaried employment (Number of salaried jobs created within the household)		

4 - WASH	Water: rate of households having access to drinking water following the existence of a well or a fountain, built in a common way within the community	1	0,25155
	Sanitation: Rate of households with access to sanitation services (exchange of hygiene products and materials for water treatment and the safety of the home and its immediate environments within the community)		
<b>Cultural criterion</b>		<b>Score</b>	<b>Index</b>
Traditional knowledge	Number of traditional knowledge (including anthropological practices) within the community	5	1,0000
	Rate of households that participated in the exchange of traditional knowledge on disaster risk (including anthropological practices)		
<b>Institutional criterion</b>		<b>Score</b>	<b>Index</b>
1 - Customary rights and practices	Rate of households using material mutual aid within an association or between households	4	0,79281455
	Rate of households using financial assistance within an association or between households		
	Rate of households using mutual aid between persons (individuals) or between households		
2 – Governance	Rate households informed and sensitized on the existence of a local functional DRM structure	4	0,76409542
	Rate of households informed and sensitized on the existence of a DRM local plan		
	Rate of households informed and made aware of the existence of a local map of risks and / or vulnerabilities		
<b>Organizational criterion</b>		<b>Score</b>	<b>Index</b>
1 - Structure and Community Coordination Mechanism	Rates of households belonging to a community coordination structure	0	0,07677553
	Rate of households informed and sensitized on the existence of a Community coordination mechanism		
2 - Structure and decision-making mechanism containing the definition of the roles and responsibilities of the actors	Rate of households informed and made aware of the existence of a community decision-making mechanism	1	0,15337199
	Rate of households participating in a functional community decision-making mechanism		
3 - Existence of village community	Number of existing village community granaries	3	0,475219

granaries	Rate of household members of village community granaries		
	Rate of households with food and product stocks at village community granaries		
4- Early Warning System (EWS)	Rate of informed households on the existence of an early warning information system	0	0,01780563
	Rate of households sensitized and applying the early warning information system		
<b>Environmental criterion</b>		<b>Score</b>	<b>Index</b>
1 - Number of environmental protection activities	Number of environmental protection activities in the community (reforestation activity carried out in a common way within the community)	1	0,1683213
2 - Availability of environmental products and services	Rate of households informed and aware of the existence of environmental products / services (banana tree, fruit tree)	3	0,56295939
	Rate of households with access to environmental products / services		
<b>Criterion for capacity building</b>		<b>Score</b>	<b>Index</b>
1 - Training	Number of DRR trainings carried out in the community	2	0,32884607
	Number of household members who attended DRR training in the community		
	Household rate following RRC recommendations		
2 - Sensitization	Number of WASH sensitizations, health and hygiene, food and nutrition carried out within the community	3	0,49059991
	Number of household members who attended outreach sessions in the community		
	Household rate following the recommendations of the awareness sessions		
3 - Popularization	Rate of households having popularized the information and knowledge obtained during training sessions and sensitization sessions	4	0,6244465
	Number of household members who participated in community outreach		
4 - Simulation exercise	Number of household members participating in periodic community-based disaster simulation exercises	5	0,99415205