

A Proposed Geoheritage Inventory System: Case Study of Isalo National Park, Madagascar

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Received 22 February 2016; accepted 22 May 2016; published 25 May 2016

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Abstract

Geological heritage inventory procedures and templates have been principally emerged from European countries. Each of these countries has developed its proper method of inventory based on its natural heritage, recognized on local and/or regional scales. Natural sites were mainly identified and characterized in a particular geological context, which is usually very unique, valuable and impressive; resulting in the protection of the sites. Madagascar is known internationally as a beautifully landscaped island, but the impressive sites were not cataloged. We carried out a series of field inventory of potential geological sites within the Isalo National Park in southern Madagascar. We invented several inventory sheets in order to record the most detailed information about the sites identified within the park. This is to aid in organizing the park and to establish a sustainable base for the creation of a geopark, and also they help us to build a database for geosites and their classifications. This article suggests a prototype model for inventorying intangible geosites, paleosites and geomorphosites. Our inventory sheets help to identify and to promote geological importance of any sites, not only for academia but also for other sectors such as tourism and conservation.

Keywords

Inventory Sheets, Geoheritage, Geosites, Paleosites, Geomorphosites, Park National, Isalo Park, Madagascar

1. Introduction

During the last decade, the concepts of sustainable development and ecotourism have expanded globally and have become as the most important parts of the geoconservation and valorization of geoheritage [1]-[4].

In developing countries such as Madagascar, these two concepts should combine the idea of the process by which a country uses to improve key sectors (economic, health, education and gender) and the environmental awareness that is essential for protecting the natural environment (biodiversity and geodiversity) [5]. Thus, several nations developed a plan of action to promote natural geological heritage in order to improve the protection of the environment [6]. Many authors already proposed different techniques that might be used to identify and classify geological sites; these sites must be unique, unusual, having a particular geological context and well preserved and deserve to be highlighted and protected [7]-[9]. In order to protect these sites (geosites, paleosites and geomorphosites), we need to identify and promote them not only for the sake of sciences but also and more importantly for the development of a sustainable tourism in such areas.

In Madagascar or in any other African countries, conservation is primarily focused on rare and endangered species and is used to draw the attention of national and international communities on the issue of conservation sites [10]-[12] while expressions of interest on the valorization of geological interest in socio-economic and tourism related sectors are limited or non-existent, which limits the scope of implementation efforts [5], [13] and [14]. Accordingly, the aim of this paper is to establish a prototype sheets for inventory of geoheritage appropriately adapted not only for Madagascar but also for other developing countries. Despite the existence of different types of inventory sheets [15]-[22], there has been only limited and a few inventory sheets that can be used directly for Madagascar's geosites, hence a new compiled inventory ones are made to overcome the issues.

2. Methodology

2.1. Typology of Geological Sites for Inventory: Geosites/Geomorphosites/Paleosites

Considering the designation of the geological sites proposed in many geologic and geographic literatures (Wimbleton *et al.*, 2000 [15], Reynard *et al.*, 2007 [16], Iosif, 2014 [23], Giusti & Calvet, 2010 [24] and Golonka *et al.* 2014 [25]) and the main works of Ielenicz, 2009 [26] and Luger *et al.* [27], which distinguished the geotope/geosite to the geomorphosite in order to classify the tourist value of the site; **Table 1** was established as a classification flow of geological features adopted in this present work. This classification is more flexible and easy to use in the field; in addition it can be used for complex geosites not only the rare geosites but also geosites with noticeable changes over a short-time period.

2.2. Proposal Prototype Sheets of Geosites/Geomorphosites/Paleosites Inventories of Madagascar

The inventory of geosites, paleosites and geomorphosites are crucial and very important for the purpose of integrative regional development ([7] [28]-[30]).

This work focuses on Isalo National Park, a park that is already protected. The preliminary approach to the implementation process of geoconservation shows without any doubts the abundance of natural heritage within the park, particularly the geosites [14].

Taking into account all relevant bibliographical revision which aim to recognition of every possible geosite inventories, the methodology of this paper is based on different approaches suggested by many researchers ([16]-[22], the Italian Superior Institute Superior for Environmental Protection and Research (ISPRA: "Istituto Superiore per la Protezione e la Ricerca Ambientale") and Madageoheritage. Accordingly, Madageoheritage has

Table 1. Typology of geological sites used in inventory sheets.

Basic typology of the site		GEOTOPE/GEOSITE	GEOMORPHOSITE	PALEOSITE
Characteristic	CODE	GEOT	GEOM	PALE
Common characteristic			Geologic objects having heritage values	
Spatial value		Geological unit	Geological unit, largest part of relief	
				Paleontological unit

proposed the prototype sheets of geosites/geomorphosites/paleosites inventories of Madagascar [5]. Because of many similarities between geosites found in Madagascar and abroad the inventory sheets were inspired from the descriptive sheets of ISPRA and were modified to fit the Malagasy geosites (recording more detailed characteristics and focusing more on the rarity and complexity of Malagasy geosites). The sheets were also designed for both previously known and unknown (potential) geosites and will be used by the Madagascar National Parks (MNP) at Isalo National Park [31]. The inventory sheets can assess the distribution of geological sites within the national parks and they can be used to categorize the sites according to their scientific and touristic values. Geosites of scientific importance can be valued as educational sites and those with tourism value can be used to promote geotourism; both will help to reduce local poverty.

2.3. Description of Inventory Sheets

The sheets were constructed using Canevas 12 software and were designed to be used in the field (Figure 1) and to be converted into a digital format (Figures 5-7) for the compilation of digital database.

Inventory sheet number one

Figure 2 shows all information and criteria used in the inventory sheets followed by explanation in order to compile the general data on the geological site:

- Information of the protected area and the geological site: property, toponym, location coordinates; identification code and the compiler.
- Detailed graphic presentation of the geological site: picture and geological map.
- Scientific interest which generate the assessment, contextual interests and scientific interest degree.
- Compiler: name of the compiler or symbol of the institution (university; association, NGO...) (e.g. Mada-geoheritage).

PARC NATIONAL ISALO		PISCINE NATURELLE		LE CRÂNE		COORD.	WGS84 - UMTS3N	E	45d 22m 19.55s
									22d 33m 39.0s
SOIL AND FLOOR		RISQUE DE DEGRADATION NATURELLE							
<input type="checkbox"/> BOIS <input type="checkbox"/> ELEVAGE <input type="checkbox"/> TERRASSE <input type="checkbox"/> DECHARGE <input type="checkbox"/> VEGETATION <input type="checkbox"/> URBAIN <input type="checkbox"/> URB. ave INFRASTR. <input type="checkbox"/> SAVANE <input checked="" type="checkbox"/> SAUVAGE 		<input checked="" type="checkbox"/> HIGH <input type="checkbox"/> MIDDLE <input type="checkbox"/> LOW <input type="checkbox"/> NON EXISTENT							
FLOOR		RISQUE DE DEGRADATION ANTHROPIQUE							
<input type="checkbox"/> SILT <input type="checkbox"/> AFFLEUREMENT <input type="checkbox"/> GRAVIER <input type="checkbox"/> SCATTERED BLOCKS <input checked="" type="checkbox"/> SABLE <input type="checkbox"/> DEBRIS <input type="checkbox"/> SAVANNE <input type="checkbox"/> MIXTE 		<input type="checkbox"/> HIGH <input type="checkbox"/> MIDDLE <input type="checkbox"/> LOW <input checked="" type="checkbox"/> NON EXISTENT							
PROTECTION AND LIMITS		PROPOSITION DE PROTECTION / INSTITUTION D'UNE SPECIFIQUE AIRE PROTEGEE							
LE SITE APPARTIENT IL A UNE AIRE PROTEGEE? <input type="checkbox"/> OUI <input type="checkbox"/> NON DEFINITION <input checked="" type="checkbox"/> PARC NATIONAL NOM DE L'AIRE PROTEGEE: <u>PARC NATIONAL ISALO</u> <input type="checkbox"/> PARK REGIONAL <input type="checkbox"/> RESERVE NATUREL <input type="checkbox"/> OASIS <input type="checkbox"/> MONUMENT NATUREL <input type="checkbox"/> GEOTOPES/BIOTOPES <input type="checkbox"/> AIRE PROTEG. MARINE <input type="checkbox"/> PARC URBAIN <input type="checkbox"/> PARC ARCHEOLOGIQUE <input type="checkbox"/> PARC MINIER <input type="checkbox"/> AUTRE AUTRES LIMITES		<input checked="" type="checkbox"/> NECESSAIRE <input type="checkbox"/> RECOMMANDEE <input type="checkbox"/> REDONDANT <input type="checkbox"/> REALISEE LEGENDES / PEUPLES <div style="text-align: center;">NO</div>							
COMPILER		SUPERVISEURS							
RANDRIANALY <input type="checkbox"/> BIEN <input checked="" type="checkbox"/> MODERE <input type="checkbox"/> EN EXTINCTION <input type="checkbox"/> MAUVAIS		RANDRIANALY							

pag. 3

Figure 1. Model of inventory sheet “number three” filled during the fieldwork in Isalo Park.

PROPERTY Property of the terrain or the geology object: name and logo Symbol of Institution, protected area (National Park), association, NGO, private, common....	TOPONYM Used to identify, both the basic typology of the site (geosite/paleosite/geomorphosite) and name of the site and also the history that accompanies it. e.g Geosite _skull of Isalo (Crâne de l'Isalo)	LOCATION Gives some geographic informations of the place as precise as possible	COORDINATES geographic coordinates are expressed in degrees, minutes and seconds
SCIENTIFIC INTEREST All branch of geoheritage (Mineralogy, paleontology, volcanology, sedimentology...) that allow their potentiality value.	PICTURE Required a good quality more than 300 dpi.		CONTEXTUAL INTERESTS The highlighting of geosites, geomorphosites and paleosites could generate a possibility of combination with other contextual interests (Cultural, Historical, Educational, Floristic, Faunistic.....) which are additional values for improving their valorization
ASSESSMENT of SCIENTIFIC INTEREST concerns 3 mains criteria : - rareness or singleness in the region - representativeness: site's exemplarity (process, evolution...) - Integrity: degree of remaining face to anthropic actor....			
SCIENTIFIC INTEREST DEGREE Used with respect to a reference space (Local, regional, National or International)	IDENTIFICATION CODE includes 3 parts: -Region/ locality (3 letters) :e.g. Parc National Isalo (PNI) -Type of the geologic object (4 letters): Geosite/Geotope (GEOT) - Paleosite (PALE) - Geomorphosite (GEOM) -The Number of the site . E.g:PNI GEOT0001 is the code of the first site at the National Park Isalo.		GEOLOGICAL MAP provides a map location of the site in the protected area
COMPILER			

Figure 2. Prototype detailed of inventory sheet “number one”.

Inventory sheet number two (Figure 3)

The sheet is divided mainly into two parts, except the header, which is the same for all cards.

- On one side, the description of morphogenesis of the site. Under this strand are defined geological values of the site: general and genetic description, lithology and morphogenesis.
- On the other side are all of the characteristics of the site: typology (single or combination of elements); Structure of the area (e.g. punctual, panoramic); originality; the position of the site (in surface or submerged); accessibility (on foot, vehicle, bike or other): degree of accessibility (easy, hard, inaccessible) and season suggested for the visit.

Inventory sheet number three

Figure 4 represents the inventory sheet number 3 and is designed to collect any other secondary information of the site:

- Composition of soil/sediment and its use.
- Type of protection (Natural reserve, Park or other).
- Level of preservation (natural and/or anthropic degradation).
- The existence of any stories, myths or legends about the geological site that could make the site more attractive to tourist and may help the MNP to develop a specific protection procedure.

2.4. Inventory Process

As parts of the process of geoconservation and protection of potential geosites, details description of sites are required and maximum amount of information are needed [27], therefore the inventory procedure progressively followed the following steps:

- Data acquisition and collection, in which the methodology approach of the study were compiled with most of the data collected during site fieldworks.
- Data compilation using spatial data analysis (GIS) based on geological, geomorphological, geodiversity and biodiversity. This provides more scientific and touristic details about the sites and improves the geological map of Isalo National Park. This step usually starts with the scanning of filled sheets from the field.
- Inventorying geotopes according to their code, and that will be included in a Madagascar database (e.g. geotopes database of national parks).

Final compilation: this database compiled by a software will be hosted in a plat-form.

PROPERTY Property of the terrain or the geology object: name and logo Symbol of Institution, protected area (National Park), association, NGO, private, common....)	TOPONYM Used to identify, both the basic typology of the site (geosite/paleosite/geomorphosite) and name of the site and also the history that accompanies it. e.g Geosite_skull of Isalo	LOCATION Gives some geographic informations of the place as precise as possible	COORDINATES geographic coordinates are expressed in degrees, minutes and seconds
DESCRIPTION OF GEOSITE/GEOMORPHOSITE/PALEOSITE This part must raise a detail description of the site (geosite ; paleosite ; geomorphosite), taking account both observations in field work and analysis from reference documents		4 parts characterized physico data of the site TYPOLOGY: single element or combination of elements STRUCTURE: is the geometry of the site (linear, punctual, areal.....) EXPOSITION TYPE: natural , artificial USABILITY OF AREA /OBJECT - Position: give more detailed of the position of the site in relation to the surface: epigeous; ipogeous, submerged - Modality of access to the site by foot, bike, boat..... - accessibility very easy, easy.....	
DESCRIPTION OF GENETIC /EVOLUTIVE PROCESS Gives more explanation about the genesis/geomorphogenesis of the site			
COMPILER Randrianaly Hasina Nirina		PAGE 2	

Figure 3. Prototype detailed of inventory sheet “number two”.

PROPERTY Property of the terrain or the geology object: name and logo Symbol of Institution, protected area (National Park), association, NGO, private, common....)	TOPONYM Used to identify, both the basic typology of the site (geosite/paleosite/geomorphosite) and name of the site and also the history that accompanies it. e.g Geosite_skull of Isalo	LOCATION Gives some geographic informations of the place as precise as possible	COORDINATES geographic coordinates are expressed in degrees, minutes and seconds
SOIL characteristics of the given area: Farmed, Vegetate, Wooded, Urbanized..... FLOOR: identify the composition of floor: silt, gravel, outcrop rock.....		NATURAL AND HUMAN DEGRADATION RISK: State of the degradation risk of the natural area	
PROTECTION AND LIMITS Name and definition of the area: Typology of the protected area (National park, Natural reserve, Minierary park.....)		PROTECTION PROPOSAL / INSTITUTION of SPECIFIC PROTECTION AREA: proposal of protection measures	
		LEGENDS/FOLKS: stories, anecdotes, myths and legends drawn primarily from the site/area.	
COMPILER		PAGE 3	

Figure 4. Prototype detailed of inventory sheet “number three”.

3. Results and Discussion: Why Geosites/Geomorphosites/Paleosites Should Be Classified of on the Basis of Tourist Value?

Madagascar's economy relies heavily on tourism. In fact all National parks in Madagascar are designed to attract tourism both international and local tourists. That is the reason why geoheritage inventory takes an important place by valuing tourism



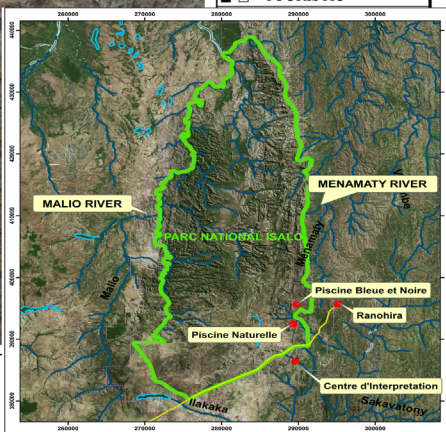
Geoheritage inventory system existed [15], [17] and [22], however they cannot be directly adopted to the Madagascar's geosites, either the inventory sheets were designed to cover a regional scale or they are lacking in detail. Besides, geosites found in Isalo National Parks and in other parks in Madagascar are so specific and unusual, which require more detail inventory sheets that can be flexible and easy to change.

3.1. Identification and Inventory of Sites: Simulation Process in Isalo Park

According to all information gathered in each inventory sheet, the identification and inventory, add more details explanation and understanding of the potential geosite/paleosite/geomorphosite. **Figures 5-7** are examples of completed sheets. The application of this inventory procedure is advantageous for Isalo park because the park is a protected area which hides numerous geological objects that can be seen on several angles as a touristic attractive object, recreational and educational. The main goal is that these should become more easier understood by the general public.

3.2. Potential Benefits of Using Geosite Cards

The proposed inventory sheets here may be used both as a check list (**Figure 1**) and as a database (**Figures 5-7**).

 Parc National Isalo BP. 6 Ranohira - 313 Ihosy		NAME OF GEOSITE SKULL of ISALO	TOPONYM South East of the Park District Ranohira, situated on mid-way between parking and Natural swimming pool	COORD. E S 22d 33m 39,00s
SCIENTIFIC INTEREST <input checked="" type="checkbox"/> GEOGRAPHY <input type="checkbox"/> STRATIGRAPHY <input type="checkbox"/> MARINE GEOLOGY <input type="checkbox"/> MINE <input type="checkbox"/> GEOMORPHOLOGY <input type="checkbox"/> APPLIED GEOLOGY <input type="checkbox"/> HYDROGEOLOGY <input type="checkbox"/> MINERALOGY <input type="checkbox"/> PALEONTOLOGY <input type="checkbox"/> PEDOLOGY <input type="checkbox"/> PETROGRAPHY <input type="checkbox"/> VOLCANOLOGY <input type="checkbox"/> SEDIMENTOLOGY <input type="checkbox"/> KARST <input type="checkbox"/> GEOHISTORY <input type="checkbox"/> GEOTOURISM <input type="checkbox"/> ARCHEOLOGY ASSESSMENT SCIENT. INTER. <input type="checkbox"/> RARE <input type="checkbox"/> EXEMPLIFYING <input type="checkbox"/> REPRESENTATIVE SCIENT. INTER. DEGREE <input checked="" type="checkbox"/> LOCAL <input type="checkbox"/> REGIONAL <input type="checkbox"/> NATIONAL <input type="checkbox"/> INTERNATIONAL			CONTEXTUAL INTEREST <input type="checkbox"/> CULTURAL <input type="checkbox"/> FAUNISTIC <input type="checkbox"/> FLORISTIQUE <input checked="" type="checkbox"/> EDUCATIONAL <input type="checkbox"/> LANDSCAPE <input type="checkbox"/> HIKING <input type="checkbox"/> HISTORICAL <input type="checkbox"/> ARCHEOLOGICAL <input type="checkbox"/> ARCHITECTURAL <input checked="" type="checkbox"/> TOURISTIC	
COMPILER Madageoheritage	CODE PNIGEOT0001			

pag. 1

Figure 5. Digitalizing format of an inventory sheet “number one” of the geosites called “Crâne de L’Isalo”.


 Parc National Isalo BP. 6 Ranohira - 313 Ihosy	NAME OF GEOSITE	TOPONYM	COORD.	WGS84 - UTM33N	E	N 22d 33m 39,00s
	SKULL of ISALO	South East of the Park District Ranohira, situated on mid-way between parking and Natural swimming pool				
DESCRIPTION OF GEOSITE			TIPOLOGY of GEOSITE <input type="checkbox"/> SINGLE ELEMENT <input type="checkbox"/> COMB. of ELEM.			
The combined action of fluvial and wind erosion have shaped the form of the sandstone massif of Isalo ruiniform oddly carved into a hill in a form of a skull. Initiated by fluvial erosion, the wind makes its action by clearing the fine particles of the poorly cemented sandstone rock			STRUCTURE of GEOSITE <input checked="" type="checkbox"/> PUNCTUAL <input type="checkbox"/> LINEAR <input checked="" type="checkbox"/> AREAL <input type="checkbox"/> PANORAMIC			
CONNOTATIVE LITOLOGY The Isalo massif consists of a formed continental sedimentation rock clastic sedimentary ie formed of mineral particles resulting from the fragmentation preexisting rocks of crystalline basement			EXPOSITION of GEOSITE <input checked="" type="checkbox"/> NATURAL <input type="checkbox"/> ARTIFICIAL			
OTHER MAIN LITOLOGY The clastic rocks of Isalo are often pink and light color with intercalation of both conglomerates and coarse particles sandstone which is composed mainly by quartz-rich siliciclastic) of feldpaths and black mica			USABILITY of AREA/OBJECT - POSITION <input checked="" type="checkbox"/> SURFACE - EPIG. <input type="checkbox"/> SURFACE - IPOGEOUS <input type="checkbox"/> SURFACE - EPIGEOUS & IPOGEOUS <input type="checkbox"/> PARTIAL. SURFACE or SUBMERGED - EPIGEOUS <input type="checkbox"/> PARTIAL. SURFACE or SUBMERGED - IPOGEOUS <input type="checkbox"/> SUBMERGED - EPIGEOUS - VISIB. from SURFACE <input type="checkbox"/> SUBMERGED - EPIGEOUS - VISIB. from DIVING <input type="checkbox"/> SUBMERGED - IPOGEOUS - VISIB. from SURFACE <input type="checkbox"/> SUBMERGED - IPOGEOUS - VISIB. from DIVING <input type="checkbox"/> SUBMERGED - EPIG. or IPOG. - VISIB. from SURF. <input type="checkbox"/> SUBMERGED - EPIG. or IPOG. - VISIB. from DIVING			
AGE As an integral part of the Isalo Park, the Isalo massif is an exceptional stratotype stratigraphic of the top part of the Karoo group, belonging to the formation of Isalo I: Isalo I (one) is the basis of the three subdivisions of Isalo. Age Triassic to Middle Jurassic). This massive head belongs to the Upper Triassic Isalo I			USABILITY of AREA/OBJECT - MODALITY OF ACCESS <input type="checkbox"/> EASY <input type="checkbox"/> HARD <input checked="" type="checkbox"/> WALKING <input type="checkbox"/> HORSE/MULE <input type="checkbox"/> BIKE <input type="checkbox"/> OFF-ROAD VEHICLE <input type="checkbox"/> CAR <input type="checkbox"/> MTB <input type="checkbox"/> BOAT <input type="checkbox"/> ELICOPTER <input type="checkbox"/>			
DESCRIPTION of GENETIC/EVOLUTIVE PROCESSES The weakly cemented sandstone whose consistency is mainly due to compaction is easily eroded by wind and fluvial agents, which explains the appearance of ruiniform Isalo. the massif interbedded of sandy easily clayed over the more resistant coarse sand leave			USABILITY of AREA/OBJECT - ACCESSIBILITY <input type="checkbox"/> VERY EASY <input checked="" type="checkbox"/> EASY <input type="checkbox"/> HARD <input type="checkbox"/> VERY HARD <input type="checkbox"/> FOR EXPERT SEASON SUGGESTED <input type="checkbox"/> WINTER <input type="checkbox"/> SPRING <input type="checkbox"/> SUMMER <input type="checkbox"/> AUTUMN <input type="checkbox"/> SPRING - AUT. <input type="checkbox"/> AUTUMN - SPR. <input checked="" type="checkbox"/> ALL YEAR			
hollow parts more or less important, have shaped the eyes of the "skull" in the Isalo Park.			AGE SITE VISIBLE from a DISTANCE <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO			
COMPILER	Randrianaly Hasina		pag. 2			

Figure 6. Digitalizing format of an inventory sheet "number two" of the geosites called "Crâne de L'Isalo".


 Parc National Isalo BP. 6 Ranohira - 313 Ihosy	NAME OF GEOSITE	TOPONYM	COORD.	WGS84 - UTM33N	E	N 22d 33m 39,00s
	SKULL of ISALO	South East of the Park District Ranohira, situated on mid-way between parking and Natural swimming pool				
SOIL AND FLOOR <input type="checkbox"/> WOODED <input type="checkbox"/> FARMED <input type="checkbox"/> TERRACED <input type="checkbox"/> LANDFILL <input type="checkbox"/> <input type="checkbox"/> URBANIZED <input type="checkbox"/> URB. with INFRASTR. <input type="checkbox"/> GRASS <input checked="" type="checkbox"/> WILD <input type="checkbox"/>			NATURAL DEGRADATION RISK <input checked="" type="checkbox"/> HIGH <input type="checkbox"/> LOW <input type="checkbox"/> NON EXISTENT			
FLOOR <input checked="" type="checkbox"/> SILT <input checked="" type="checkbox"/> OUTCROP ROCK <input type="checkbox"/> GRAVEL <input type="checkbox"/> SCATTERED BLOCKS <input checked="" type="checkbox"/> SAND <input type="checkbox"/> DEBRIS <input type="checkbox"/> MIXED <input type="checkbox"/>			HUMAN DEGRADATION RISK <input type="checkbox"/> HIGH <input type="checkbox"/> LOW <input type="checkbox"/> NON EXISTENT			
THE SITE BELONGS TO PROTECTED AREA? <input checked="" type="checkbox"/> YES <input type="checkbox"/> NO			PROTECTION PROPOSAL / INSTITUTION OF SPECIFIC PROTECTION AREA <input checked="" type="checkbox"/> NECESSARY <input type="checkbox"/> RECOMMENDED <input type="checkbox"/> REDUNDANT <input type="checkbox"/>			
DEFINITION <input checked="" type="checkbox"/> NATIONAL PARK <input type="checkbox"/> REGIONAL PARK <input type="checkbox"/> NATURAL RESERVE <input type="checkbox"/> OASIS <input type="checkbox"/> NATURAL MONUMENT <input checked="" type="checkbox"/> GEOTOPES/BIOTOPES <input type="checkbox"/> PROTEC. MARINE AREA <input type="checkbox"/> URBAN PARK <input type="checkbox"/> ARCHEOLOGICAL PARK <input type="checkbox"/> MINERARY PARK <input type="checkbox"/> OTHER			LEGENDS / FOLKS The geosite Isalo massif took the form of head skull Small caves of rocks are used as tombs			
NAME OF PROTECTED AREA Isalo National Park			SURVEYORS All data in field are carried out by 4 master students supervised by Dr. Randrianaly Hasina and Pr Tsilavo Raharimahafa			
OTHER KIND OF LIMITS			PRESERVATION DEGREE <input type="checkbox"/> GOOD <input checked="" type="checkbox"/> MODERATE <input type="checkbox"/> AWFUL <input type="checkbox"/> EXINCT			
COMPILER	Madageoheritage		pag. 3			

Figure 7. Digitalizing format of an inventory sheet "number three" of the geosites called "Crâne de L'Isalo".

As check list, the inventory sheets could be used directly on the field in order to describe and formalize a site as a geo- and/or paleo-site. The sheets allow us to classify every geographic, geological, geomorphological information on a site. Also, these allow us to collect information such as accessibility and point of interest.

In contrast to the ISPRA format, our inventory sheets included a section to record any previous histories, myths and legends about the geosites. Randrianaly *et al.* 2015 ([5]), explains the importance of stories about geological and paleontological features. Knowing the histories, the myths or legends about the geosites helped the compiler during his or her approach with the native and the locals. To attract visitor (scientists or tourists) these historical values can be included in the geosite database and could be published in museums, libraries and even on the park websites.

As an example, one geosite located in the East of the park is illustrated in the **Figure 6**.

3.3. The Importance of Inventorying

According these inventory sheets, we strongly affirm that inventory and evaluation of the geoheritage are the best way to tackle and to overcome the challenge associated with the implementation of the geoconservation in Madagascar. The completion of the inventory of geosites within the Isalo Park shows that geosites values are based in four criteria (**Figure 8**) [5].

- The inventory of each geosite promotes its scientific values (rarity, integrity and diversity) [16].
- The inventory data brings additional explanation of the geology for scientists and promote local and international tourism, and attract visitor [32].
- Geosites could be used as additional esthetic, ecological and cultural values ([33] and [34]). For example, the deep canyon with evergreen forest in Isalo National Park is considered as a natural beauty because of the landscape and also known as a sacred/holy site.
- The potentialities of the sites highlighted the geotourism, a sustainable strategy towards the ecotourism for Madagascar, which may help to reduce poverty and may improve and create a more sustainable development.

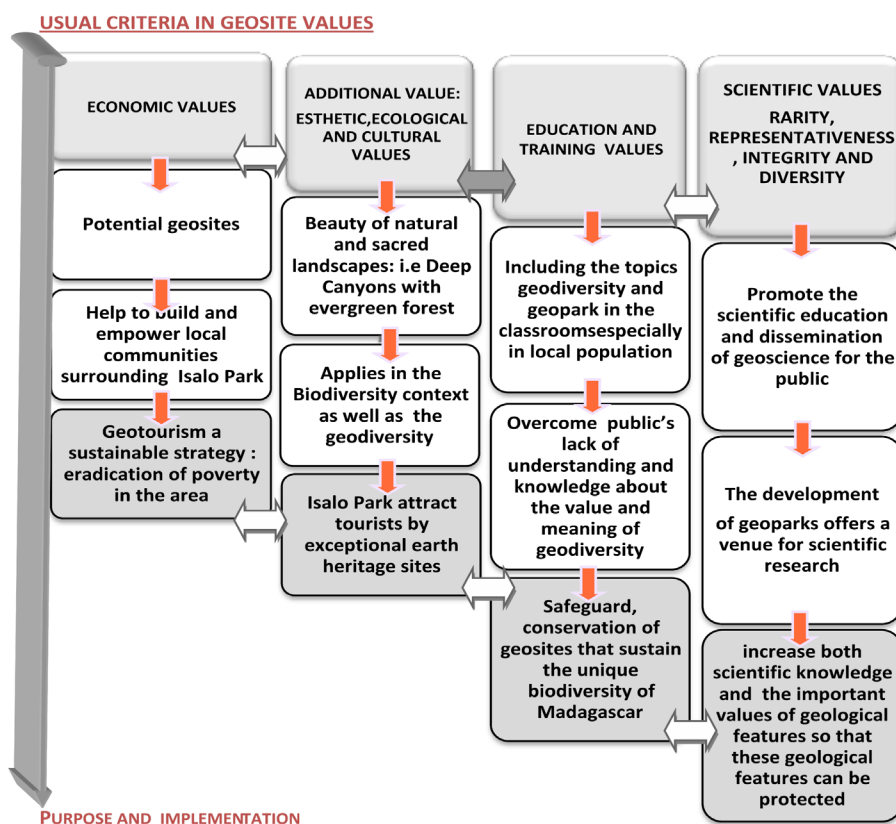


Figure 8. Synthesis graph of geosites values relevant to the current issues to Madagascar (Randrianaly *et al.* 2015).

These results showed that inventorying geosites are not only restricted to scientific researches but also help to promote the educational, socio cultural, ecological values of the park.

4. Conclusions

To maintain a sustainable natural ecosystem, we should consider and protect the geosites. Their identification allows a better understanding of geological heritage, which should be kept for future generations.

However, in order for a geological site to be a part of the geological heritage, it must be acknowledged and must be the subject of collective ownership.

We proposed for the first time the prototypes of inventory sheets of any geosites. The creation of these sheets was based on the inventory done within the Isalo National Park and was based on the knowledge of the sites and their issues. The inventory of Isalo's geosites was completed in order to produce a plan of action and to improve the management work plan for the park.

The uses of these inventory sheets have resulted into the creation of digital database that integrated geological sites of special interest in the area. In addition, these prototypes can be published online in other media in order to promote the disclosure of all necessary information to implement improve the geotourism sector.

The inventory works demonstrate that it is possible to apply the same thematic areas in remote places which are so distant and different.

Acknowledgements

We wish to sincerely thank the cooperation with Italian Superior Institute Superior for Environmental Protection and Research (ISPRA: "Istituto Superiore per la Protezione e la Ricerca Ambientale") giving us the authorization for using and modifying their inventory sheet. We are also very grateful to Madagascar National Parks for collaboration and interest with Madageoheritage for the instauration of the geotourism as the project pilot in National Isalo Park. Special thanks are given to journal's GEP editor and to the two reviewers: their comments and input are appreciated.

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